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VEGETATION MANAGEMENT WITH HERBICIDES

WESTERN OREGON

Draft Environmental Statement
1978

Volume I

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Addendum

Vegetation Management With Herbicides

Western Oregon

Draft Environmental Statement

The following changes should be made to the statement.

Page 3-146, Item 2, add the following sentence: "It seems reasonable to conclude that Silvex (which also contains the dioxin) presents a potential for a long-term environmental risk."

Page 4-6, Human Health, delete last paragraph, left hand column, and replace with the following:

"The safety margin in relation to human health established for herbicides containing TCDD (dioxin) has been judged by an EPA committee not to have an adequate margin of safety for women of child-bearing age exposed to cumulative oral and inhalation exposure of 2,4,5-T and TCDD. The basis for this judgment is subject to public review through the "RPAR" process."

Page 6-5, delete sentence at top of page and replace with the following:

"Except for Silvex, no long-term human health effects are known to result from the proposed action. An EPA committee has made the judgment that an adequate margin of safety does not exist for women of child-bearing age exposed to cumulative effects of dermal, oral, and inhalation exposure of 2,4,5-T and TCDD. The basis for this judgment is subject to public review through the "RPAR" process."

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DEPARTMENT OF THE INTERIOR

DRAFT
ENVIRONMENTAL STATEMENT

VEGETATION MANAGEMENT WITH HERBICIDES: WESTERN OREGON 1978 through 1987

Prepared by

BUREAU OF LAND MANAGEMENT
DEPARTMENT OF THE INTERIOR

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SUMMARY

Draft (X) Final ( ) Environmental Statement

Administrative (X) Legislative ( )

I. Type of Action

II. Description of the Action

The Bureau of Land Management proposes to use herbicides registered with EPA to manage vegetation on approximately 74,500 acres annually in western Oregon. Primary uses include: 1) The preparation of forest lands for tree planting; 2) Release of planted trees from competing vegetation; 3) Maintenance of roads, utility rights-of-way and other improvements and control of poisonous and noxious weeds. Methods of application include aerial (helicopter), truck mounted equipment, hand held devices and direct hand application. Estimated cost of the program is $2,000,000 annually.

The program described in this statement typifies the annual herbicide use proposed by the Bureau in western Oregon. It is intended that the data on environmental impacts and effects of the proposed program will apply on a continuing basis. Changes in EPA classifications or registered uses of herbicides will be immediately adopted by the Bureau. Each district office will annually prepare an environmental analysis record (EAR) of its proposed herbicide use. The EAR will supplement the information in this Environmental Statement. The projects illustrated in Appendix "D" typify the material that will be contained in each EAR. Proposed projects will be reviewed and approved on an annual basis. The herbicides proposed for use include: 2,4-D, Silvex, Simazine, Atrazine, Diuron, Tordon, Dalapon, Banvel, and Roundup. In 1978 they are proposed for use on 74,436 acres of the public land administered by the Bureau in western Oregon. More than one-half of the proposed program for 1978 involves the use of Silvex (42,000) acres.

III. Summary of Environmental Impacts

The vigor and population of target and associated vegetation susceptible to the herbicides proposed for application will be reduced. Non-target plants, especially conifers, will increase in vigor and population. Rare and endangered plants located in proposed treatment areas may be damaged or killed if not identified during planned pre-treatment floristic surveys.

Impacts to water and aquatic organisms are small and short term. Major accidental spills of concentrated herbicide in streams or water bodies are a remote possibility. Impacts would be the heaviest in the immediate area to fish populations and diminishing with time and downstream distance from the impact area.

Soil and soil microorganisms will not be adversely impacted.

Population of some species of wildlife will increase and others will decrease. Total wildlife numbers and diversity will be reduced. No known endangered or threatened wildlife species are located in proposed project areas. No species of wildlife will be eliminated by the proposed action.

Scenic vistas in some areas may be adversely impacted by the appearance of vegetation treated with herbicides.

Man's health will not be adversely impacted by the proposed action except for rare vehicle or equipment accidents. EPA is currently involved in a process of examining the human health hazard of 2,4,5-T and its contaminant (TCDD-Dioxin). This contaminant is also in Silvex.

Sensitive areas are agricultural lands, residences, non-forest land uses located adjacent to project areas and downstream water users such as fish hatcheries, drinking water and irrigation withdrawals. The rural location of the proposed forestry applications and mitigating measures included in this statement will minimize sensitive area impacts.

IV. Alternatives Considered

A. Vegetation management with all available herbicides except Silvex.
B. Vegetation management without chemical herbicides.
C. No vegetation management of any kind.

V. Comments Will be Requested From: (See Attachment)

VI. Date Draft Statement Made Available to EPA and the Public

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Federal Agencies

Advisory Council on Historic Preservation

Department of Agriculture
- Forest Service
- Soil Conservation Service

Department of Defense
- Army Corps of Engineers

Department of Energy
- Bonneville Power Administration

Department of the Interior
- Bureau of Reclamation
- Bureau of Outdoor Recreation
- National Park Service
- Fish and Wildlife Service

Environmental Protection Agency

Pacific Northwest River Basin Commission

Small Business Administration

Water Resources Council

State and Local Government

Boards of County Commissioners
- Coos County
- Curry County
- Douglas County
- Jackson County
- Josephine County
- Klamath County
- Lane County

Oregon State Board of Health

Oregon State Clearing House

Oregon State Department of Agriculture

Oregon State Department of Environmental Quality

Oregon State Department of Fish and Wildlife

Oregon State Department of Forestry

Oregon State Historic Preservation Officer

Rogue Valley Council of Governments

Interest Groups

Alliance for Better Land Management
Association of O&C Counties
Audubon Society
Cascade Holistic Economic Consultants
Friends of the Earth
Headwaters Association
Industrial Forestry Association
Izaak Walton League
Josephine Conservation Coalition
League of Women Voters
Motorcycle Riders Association
National Marine Fisheries Service
National Wildlife Federation
Nature Conservancy
Natural Resources Defense Council
Northwest Environmental Defense Center
Northwest Steelheaders Club
North West Timber Association
Oregon Environmental Council
Oregon Guides and Packers Association
Oregon Wildlife Federation
Oregon State University
Oregon Student Public Interest Research Group
Rogue River Guides Association
Sierra Club
Southern Oregon Citizens Against Toxic Sprays
Southern Oregon Resources Alliance
Southern Oregon Timber Industry Association
Western Forest Industry Association
Wilderness Society
Wildlife Management Institute

Copies of the Draft Environmental Statement will be available for review by interested individuals at each district manager's office in western Oregon and the state director's office in Portland. In addition, copies will be available in local public libraries.

TABLE OF CONTENTS

CHAPTER Page

I. DESCRIPTION OF THE PROPOSED ACTION

A. Purpose and Scope..... 1- 1

B. History..... 1-24

C. Proposed Action..... 1-25

1. Geographical Location..... 1-26

2. Integrated Existing Vegetation Management Methods..... 1-28

3. Proposed Uses of Herbicides..... 1-31

4. Methods of Application..... 1-37

5. Timing of Application..... 1-40

6. Selection of Herbicides..... 1-46

7. Controls and Safety in the Use of Herbicides..... 1-55

8. Project Design Features..... 1-58

9. Interrelationships..... 1-69

II. DESCRIPTION OF THE EXISTING ENVIRONMENT..... 2- 1

A. Description of Vegetative Biomes..... 2- 1

B. Terrestrial Vegetation..... 2- 4

C. Terrestrial Wildlife..... 2-12

D. Soil..... 2-33

E. Aquatic Organisms..... 2-44

F. Water..... 2-63

G. Visual Resources..... 2-71

H. Man (Human)..... 2-76

Chapter | Page

II. (continued)

H. Sensitive Areas..... 2-86

I. Description of the Future Environment..... 2-87

III. ENVIRONMENTAL IMPACTS OF THE PROPOSED ACTION

A. Background..... 3- 1

B. Introduction..... 3- 3

C. Terrestrial Vegetation..... 3- 4

D. Terrestrial Wildlife..... 3-25

E. Soil..... 3- 65

F. Aquatic Organisms..... 3- 74

G. Water..... 3-103

H. Visual Resources..... 3-123

I. Human Health..... 3-128

IV. MITIGATING MEASURES THAT WILL BE INCLUDED IN THE PROPOSED ACTION IN ADDITION TO THOSE DESCRIBED IN CHAPTER I.

A. Vegetation..... 4- 1

B. Terrestrial Wildlife..... 4- 2

C. Soil..... 4- 3

D. Aquatic Organisms - Water Quality..... 4- 3

E. Visual Resources..... 4- 5

F. Human Health..... 4- 6

Chapter Page

V. ANY ADVERSE ENVIRONMENTAL EFFECTS WHICH CANNOT BE AVOIDED SHOULD THE PROPOSAL BE IMPLEMENTED

A. Vegetation..... 5- 1

B. Terrestrial Wildlife..... 5- 2

C. Soil..... 5- 3

D. Aquatic Resources..... 5- 3

E. Water..... 5- 5

F. Visual Resources..... 5- 5

G. Human Resources..... 5- 6

VI. RELATIONSHIP BETWEEN LOCAL SHORT-TERM USES OF MANS ENVIRONMENT AND THE MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY

A. Vegetation..... 6- 1

B. Terrestrial Wildlife..... 6- 2

C. Soil..... 6- 3

D. Aquatic Resources..... 6- 3

E. Water..... 6- 4

F. Visual Resources..... 6- 4

G. Human Health..... 6- 4

VII. IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES WHICH WOULD BE INVOLVED IN THE PROPOSED ACTION SHOULD IT BE IMPLEMENTED..... 7- 1

VIII. ALTERNATIVES TO THE PROPOSED ACTION..... 8- 1

A. Vegetation Management With All Available Herbicides Except Silvex (Alternative A)..... 8- 2

B. Vegetation Management Without Herbicides..... 8-22

C. No Vegetation Management..... 8-57

Chapter Page

IX. CONSULTATION WITH OTHERS..... 9- 1

GLOSSARY

BIBLIOGRAPHY

APPENDIX A - Department of Interior Pesticide Use Policy and Guidelines

APPENDIX B - Water Monitoring Procedures

APPENDIX C - EPA, Dioxin Position Document

APPENDIX D - (See Volume II)

List of Tables

Table		Page
1.	Key Herbicide Program Data	1- 3
2.	Public Forest Land as of 6/30/75	1-26
3.	Integrated Vegetation Control Methods - 1978	1-32
4.	Proposed Uses of Herbicides (Acreage Summary)	1-37
5.	Methods of Application (Acreage Summary)	1-40
6.	Season of Application (Acreage Summary)	1-45
7.	Projected and Proposed Herbicide Program	1-53
8.	Environmental Statement Schedule	1-70
9.	Major Tree Species - Northwest Coastal Biome	2- 9
10.	Northwest Costal Sub-Biome, Competitor Plants	2-11
11.	Montane Sub-Biome Major Tree Species by Zone	2-13
12.	Montane Sub-Biome, Competitor Plants	2-14
13.	Terrestrial Wildlife, Population and Habitat Trend	2-16
14.	Terrestrial Wildlife, Acres and Condition of BLM Habitat	2-16
15.	Terrestrial Wildlife Most Representative of Western Oregon	2-18
16.	Birds Found in Western Oregon	2-19
17.	Reptiles and Amphibians Found in Western Oregon	2-20
18.	Terrestrial Wildlife Primary Food Habitats and Items	2-26
19.	Important Orders of Insects in Western Oregon	2-28
20.	Bird Species Typical of Successional Stages	2-30
21.	Importance and Use of Two Seral Stages of Vegetation Common in the Three Western Oregon Sub-Biomes	2-31
22.	Wildlife Classified as Endangered, Threatened, Sensitive or Pending Final Rule Making	2-32
23.	Soil Physical Properties, Northwest Coastal Forest	2-36
24.	Soil Physical Properties, Montane Coniferous Forest	2-37
25.	Soil Physical Properties, Broad Sclerophyll	2-38
26.	Class I Stream Miles	2-46
27.	Freshwater Fishes Found in Western Oregon	2-52
28.	Herbicide Analysis, Integrated Flow	2-72
29.	Herbicide Analysis, Bottom Sediment	2-73
30.	Classification of Economic Areas by Degree of Dependency Upon Timber-Based Employment	2-82
31.	Summary of Herbicide Characteristics Used in Forestry	3- 5
32.	Toxicity of Mammals to various Herbicides	3-30
33.	Dietary Toxicity of Herbicides and Birds	3-32
34.	Relationship of Proposed Herbicide Application Periods to Peak Avian Reproductive Periods	3-38
35.	Bird Populations on Study Plots	3-52
36.	Relationship of Proposed Herbicide Application Periods to Peak Avian Reproductive Seasons	3-55
37.	Effects of Common Forest Herbicides on Aquatic Organisms and Recommended Maximum Concentration	3-89
38.	Results of Water Samples Taken from Selected Streams During the 1977 BLM Spray Project	3-91
39.	Relative Toxicity of Herbicide to Man	3-131
A.	Potential Substitutes for Silvex	8- 9
B.	Comparative Costs	8-10
C.	Silvex Replacement Potential	8-12

List of Figures

Figure		Page
1.	Map of Geographic Area	1- 6
2.	Map of Western Oregon-BLM Lands	1- 7
3.	Map of Vegetative Biomes	2- 3
4.	General Soil Map - Western Oregon	2-40
5.	Riparian Vegetation, Illustration	2-47
6.	Western Oregon (major drainage areas)	2-64
7.	Comparison of Tree Growth as Affected by the Removal of the A Horizon and Compaction (Keel Series)	8-43
8.	Comparison of Tree Growth as Affected by the Removal of the A Horizon and Compaction (McCully Series)	8-44
9.	A comparison of Residual Environmental Impacts Between the Proposed Action and Three Vegetation Management Alternatives	8-61

CHAPTER I

DESCRIPTION OF THE PROPOSED ACTION

PURPOSE AND SCOPE

The Bureau of Land Management proposes to use herbicides on approximately 1,900 individual treatment units annually in western Oregon. In 1978 these units total 74,436 acres of the nearly 2.4 million acres of public forest land administered by the Bureau in western Oregon. The program described herein for 1978 is considered representative of the annual program need for the next 10 years (1978-1987). The objective of the program is to; 1) sustain a high level of timber production, 2) maintain safe uninterrupted rights-of-way for powerlines, railways and roads, and 3) protect recreation site visitors from noxious plants, and livestock from poisonous plants.

The proposed action is a 10-year herbicide application program on Bureau forest lands located in five Districts in western Oregon. The herbicide program described herein typifies the projected annual herbicide program. Therefore it is used as the basis for analyzing the environmental impacts that may occur each year over the 10-year period. This environmental statement is considered applicable for a 10-year period unless it is determined through the Bureau's annual review process that it does not adequately describe the environmental effects. The annual review process is accomplished by assessing the site specific environmental impacts of each districts herbicide program proposal.

A summary of key 1978 herbicide program data that typifies the scope and purpose of the proposed annual program is shown in Table 1. Detailed project back-up data is contained in Appendix D. Subsequent yearly treatments will be comparable, subject to some differences brought about due to:

1. Updating timber management plans.
2. Different on-site environmental conditions.
3. Revised tree planting program due to losses or surplus in seedling inventories.
4. Budgetary constraints.
5. Use of new chemicals registered for forestry application.
6. Use of new vegetation management technology.

Site specific information included in Appendix D for each 1978 project includes information on: (1) acreages, (2) chemicals used, (3) plants controlled, (4) application method, (5) herbicide carrier, (6) application rate, (7) season of application, and (8) a map showing the location of each project area, in relation to adjacent streams, residences, domestic water intake, and fish hatcheries. This site specific type of information will be an integral part of the Environmental Assessment Records prepared for each program proposed after 1978. This information is the program proposed to be implemented each year.

The final decision on a vegetation management program will be made after the final environmental statement has been filed with the Environmental Protection Agency.

TABLE 1

Silvex

Target Pest	Purpose	Application Method	Active Ingredient Pounds	Total Acres	Treatment Areas	Season of Application
Ceanothus	Release	Helicopter	2,200	550	12	April-May
Madrone, Chinkapin Oak, Poison Oak	Release	Helicopter	1,200	300	8	Aug.-Sept.
Big Leaf Maple Sprouts	Site Preparation	Back Pack Sprayer	400	100	5	May-June
Vine Maple	Release, Site Preparation	Helicopter	3,752	1,876	49	March
Big Leaf Maple Sprouts-Stumps	Release, Site Preparation	Back Pack	6,356	2,270	58	Year-round
Snowbrush, Chinkapin Hazel	Release	Helicopter	357	119	3	Aug.-Sept.
Ceanothus	Release	Helicopter	102	102	3	February, Mar., Aug. Sept.
Thimbleberry, Salmonberry	Release	Helicopter	7,950	2,650	63	July, Sept.
Maple Sprouts, Stumps	Release	Back Pack	2,200	550	13	Year-round
Maple Sprouts, Stumps	Release, Site Preparation	Back Pack	2,400	600	Scattered trees	July-Sept.
Madrone, Tan Oak Live Oak, Chinkapin	Thinning	Back Pack Sprayer	1,080	90	6	April-Aug.
Totals			27,997	9,207	220	

TABLE I

Dowpon

Target Pest	Purpose	Application Method	Active Ingredient Pounds	Total Acres	Treatment Areas	Season of Application
Grasses	Release, Site Preparation		7,200	1,800	75	March-April
Grasses	Release, Site Preparation	Back-Pack Sprayer	1,500	300	11	April-May
Totals			8,700	2,100	86	

TABLE 1

Atrazine + Dalapon

Target Pest	Purpose	Application Method	Active Ingredient Pounds	Total Acres	Treatment Areas	Season of Application
Grasses	Site Preparation	Helicopter	21,600	2,700	68	February-June
Grasses	Site Preparation	Helicopter	3,700	500	12	March
Grasses	Site Preparation	Back Pack	2,760	345	12	March
Grasses	Release, Site Preparation	Helicopter	2,560	320	9	April-May
Totals			30,620	3,865	101	

TABLE 1

Atrazine + 2,4-D

Target Pest	Purpose	Application Method	Active Ingredient Pounds	Total Acres	Treatment Areas	Season of Application
Grasses, Tansy	Release, Site	Helicopter	7,776	1,296	32	March
Thistle, Dandelion	Preparation					
Grass, Alder	Site	Helicopter	840	140	5	March-April
Tan Oak	Preparation					
Totals			8,616	1,436	37	

Table 1 Banvel 520 + 2,4-D

Target Pest	Purpose	Application Method	Active Ingredient Pounds	Total Acres	Treatment Areas	Season of Application
Chinqapin Oak, Assoc. Hardwood Trees	Site Preparation	Helicopter	888	222	11	March

Table 1

Banvel 520

Target Pest	Purpose	Application Method	Active Ingredient Pounds	Total Acres	Treatment Areas	Season of Application
Alder, Vine Maple	Road Maintenance	Truck Sprayer	1,175	150	Road sides	March-July
Maple Stump Sprouts	Release	Back-pack Sprayer	2,822	974	Scattered Trees	Year-round
Totals			3,997	1,124		

TABLE 1

Tordon 101

Target Pest	Purpose	Application Method	Active Ingredient Pounds	Total Acres	Treatment Areas	Season of Application
Brush, Weeds	Site Preparation	Helicopter	3,500	700	15	June-July
Big Leaf Maple	Site Preparation	Manual Injection	914	457	10	Year-round
Big Leaf Maple	Release	Manual Injection	3,330	1,665	30	Year-round
Totals			7,744	2,822	55	

TABLE 1

Tordon 101 R

Target Pest	Purpose	Application Method	Active Ingredient Pounds	Total Acres	Treatment Areas	Season of Application
Big Leaf Maple Sprouts	Site Preparation	Manual	500	500	Scattered Trees	January-October
Big Leaf Maple Stumps	Site Preparation	Manual	1,130	1,130	Scattered Trees	July-September
Totals			1,630	1,630		

TABLE 1 Tordon K + Verton 2-D

Target Pest	Purpose	Application Method	Active Ingredient Pounds	Total Acres	Treatment Areas	Season of Application
Tan Oak, Maple, Salmonberry	Site Preparation	Helicopter	4,025	805	21	June-July

TABLE 1 Tordon 10K Pellets

Target Pest	Purpose	Application Method	Active Ingredient Pounds	Total Acres	Treatment Areas	Season of Application
Big Leaf Maple	Site Preparation	Manual	9	9	Scattered Trees	August-November

TABLE 1

Atrazine + 2,4-D + Dalapon

Target Pest	Purpose	Application Method	Active Ingredient Pounds	Total Acres	Treatment Areas	Season of Application
Grasses, weeds forbs	Site Preparation	Helicopter	10,140	1,014	28	March

TABLE 1

Krenite

Target Pest	Purpose	Application Method	Active Ingredient Pounds	Total Acres	Treatment Areas	Season of Application
Alder, Maple, Oak, Madrone, Manzanita, Chaparral	Road Maintenance	Truck Sprayer	240	20	Road sides	Aug.-Sept.
Vine Maple, Alder	Site Preparation	Helicopter	905	181	12	Aug.-Sept.
Alder, Maple, Cherry, Willow	Release	Helicopter	5,100	1,300	30	Aug.-Sept.
Red Alder, Vine Maple, Blackberry, Willow, Cherry	Release, Site Preparation	Helicopter	11,760	980	26	Aug.-Sept.
Totals			18,005	2,481	68	

TABLE 1

2,4-D

Target Pest	Purpose	Application Method	Active Ingredient Pounds	Total Acres	Treatment Areas	Season of Application
Red Alder	Release	Helicopter	2,060	1,030	23	July-August
Red Alder	Release	Helicopter	4,400	1,100	30	March-April
Madrone, Thistle	Release	Helicopter	720	360	10	March
Madrone	Release	Manual Injection	662	306	8	May-June
Madrone	Release	Manual Injection	24	12	2	May-June
Ceanothus, Hazel Alder, Madrone	Release, Site Preparation	Helicopter	2,522	1,261	45	March
Ceanothus, Hazel Alder, Oceanspray, Madrone	Release, Site Preparation	Helicopter	1,479	493	15	March
Madrone	Release	Helicopter	374	187	1	March-May
Manzanita, Ribes	Release, Site Preparation	Helicopter	555	185	9	April-May
Tansy Ragwort	Noxious Weed Control	Back-pack or Truck Sprayer	600 *	200	—	April-July
Totals			13,346	5,134	143	

TABLE 1

Weedone-170

Target Pest	Purpose	Application Method	Active Ingredient Pounds	Total Acres	Treatment Areas	Season of Application
Alder, Maple, Oak, Madrone, Manzanita, Chaparral	Road Maintenance	Stump Treatment (Back pack)	40	20	9	June-Sept.
Madrone, Willow		Knap-sack Sprayer	20	20	2	April-May
Totals			60	40	11	

TABLE 1

Diuron

Target Pest	Purpose	Application Method	Active Ingredient Pounds	Total Acres	Treatment Areas	Season of Application
Annual, Perennial Weeds and Grasses	Road Maintenance	Truck Sprayer	10,325	580	Road sides	March-June

TABLE 1

Dicamba + 2,4-D

Target Pest	Purpose	Application Method	Active Ingredient Pounds	Total Acres	Treatment Areas	Season of Application
Alder, Maple	Road Maintenance	Truck Sprayer	725	275	Road sides	Jan.-June
Willow, Alder, Maple	Road Maintenance	Truck Sprayer	300	100	Road sides	April-May
Totals			1,025	375		

TABLE 1

Silvex + 2,4-D

Target Pest	Purpose	Application Method	Active Ingredient Pounds	Total Acres	Treatment Areas	Season of Application
Alder, Vine Maple Hazel	Release	Helicopter	46,184	11,546	248	Feb.-April
Alder, Vine Maple Blackberry	Road Maintenance	Truck Sprayer	2,800	700	Road side	June-Oct.
Red Alder, Vine Maple, Big Leaf Maple, Hazel	Release	Helicopter	26,000	6,500	120	March-April
Madrone, Chinkapin Oak	Release	Helicopter	4,000	2,000	75	March-April
Vine Maple, Hazel Alder, Ceanothus	Release, Site Preparation	Helicopter	10,071	3,357	88	March
Ceanothus, Chinkapin Oak, Willow	Release	Helicopter Back-Pack	1,200	400	19	April-May
Madrone, Live Oak, Hazel	Release	Helicopter	684	228	10	March
Vine Maple, Deer-brush, Hazel, Cherry	Site Preparation	Helicopter	1,652	413	23	March-May
Chinkapin, Dearbrush, Madrone, Snowbrush	Release	Helicopter	240	96	3	Aug.-Sept.
Madrone, Manzanita, Alder, Hazel	Release	Helicopter	2,202	734	25	March
Madrone, Alder, Manzanita, Ceanothus	Release	Helicopter	3,032	1,213	19	August
Tan Oak, Live Oak, Manzanita, Madrone	Release	Helicopter	4,200	700	27	March-April
Hazel, Vine Maple, Ribes and Rubus	Release	Helicopter	1,728	288	12	March-April
Ceanothus, Chinkapin, Tan Oak	Release	Helicopter	3,868	976	30	Aug.-Sept.
Ceanothus, Chinkapin, Tan Oak, Alder, Vine Maple	Release	Helicopter	1,928	482	12	March-April
Chinkapin, Tan Oak, Live Oak	Site Preparation	Helicopter	1,368	342	1	Aug.-Sept.
Vine Maple, Deer-brush, Hazel, Cherry	Site Preparation	Helicopter	360	120	3	March-May

(continued)

TABLE 1

SILVEX + 2,4-D (Continued)

Target Pest	Purpose	Application Method	Active Ingredients Pounds	Total Acres	Treatment Areas	Season of Application
Tan oak, Salal, Manzanita, Rhododendron, Chinkapin, Oceanspray	Site Preparation	Helicopter	264	66	4	Feb.- Mar.
Manzanita, Tan oak, Salal, Rhododendron, Chinkapin, Oceanspray	Release	Helicopter	2,664	888	38	Mar.- Apr.
Manzanita, Tan oak, Salal, Rhododendron, Chinkapin, Oceanspray	Release	Helicopter	2,865	1,146	37	Sep.- Oct.
Manzanita, Tan oak, Salal, Rhododendron, Chinkapin, Oceanspray	Release		1,383	461	9	Feb.- Apr.
Manzanita, Tan oak, Salal, Rhododendron, Chinkapin, Oceanspray	Release	Helicopter	360	144	6	Feb.- Mar.
Totals			119,053	33,084	809	

TABLE 1

ATRAZINE

Target Pest	Purpose	Application Method	Active Ingredients Pounds	Total Acres	Treatment Areas	Season of Application
grass	Release, Site Preparation	Helicopter	16,400	4,100	100	Feb.-Mar.
grass	Site Preparation	Helicopter	1,600	400	13	Sept.-Nov.
grass	Site Preparation	Helicopter	1,756	439	25	April
grass	Release	Helicopter	3,940	985	17	March
grass	Release	Helicopter	440	135	3	Sep., Oct., Feb., Mar.
grass, broad leaf weeds	Site Preparation	Helicopter	588	147	6	Spring
grass	Release, Site preparation	Helicopter	104	26	1	Feb.- Mar.
grass	Release	Helicopter	1,844	461	9	Feb., Mar.
grass	Release	Helicopter	576	144	6	Feb., Mar.
grass	Release, Site Preparation	Helicopter	4,400	1,100	30	March
grass	Release	Helicopter	800	200	8	March
grass	Site Preparation	Back-pack sprayer	620	155	15	March
grass	Site preparation	Helicopter	1,200	300	8	Mar.- Apr.
Total			34,268	8,592	241	

TABLE 1

SIMAZINE

Target Pest	Purpose	Application Method	Active Ingredients Pounds	Total Areas	Treatment Areas	Season of Application
grasses, forbs	site preparation	helicopter	800	200	5	February

TABLE 1

WESTERN OREGON SUMMARY

District	Pounds of Herbicide	Acres Proposed for Treatment	No. of Areas
Salem	53,900	12,700	225
Eugene	61,544	16,475	425
Roseburg	57,326	12,663	370
Coos Bay	80,224	19,621	407
Medford	48,254	12,977	409
Total	301,248	74,436	1,836

Chemical	Pounds
Atrazine	59,976
Dalapon	27,916
Silvex	84,930
Simazine	800
Weedone-170	60
2,4-D	81,542
Banvel 520	4,219
Diuron	10,325
Tordon 101	7,744
Tordon 101R	1,630
Tordon K	814
Krenite	18,005
Dicamba	375
Verton 2-D	3,220
Total	301,248

Proposed annual herbicide use may vary within wide limits. The total number of projects and area needing treatment each year is related to the size of the tree planting program and on the seasonal growth of undesirable vegetation. However, substantial increases in the 74,436 acres projected as an average annual program over the next 10 years will be one factor considered in determining the adequacy of the statement.

HISTORY

The Bureau has managed vegetation, in its western Oregon timber management program with chemicals and nonchemical methods for more than a decade. Basic authorities are the "O&C act of 1937", "Public Law 94579, Federal Land Policy and Management Act of 1976" and Public Law 92516, "Federal Environmental Pesticide Control Act of 1972." This latter Act requires that pesticides be registered before they can be distributed in interstate commerce. Registration is not granted unless scientific evidence is provided to prove to officials of the regulatory agency that the product can be used safely and is effective when applied according to label directions. Effectiveness, safety, health, and environmental impacts are primary considerations in registering pesticides. Registered uses undergo continuous review to maintain compliance with the Act. The responsibility for administering the Act is vested in the Environmental Protection Agency.

Until 1977, the Bureau had met the requirements of the National Environmental Policy Act by preparing environmental assessments of its herbicide

project proposals. These assessments concluded that the proposed projects created no major or significant impact on the environment that required an Environmental Statement. Now, however, there is public controversy over the environmental impacts of a contaminant (TCDD or Dioxin) in 2,4,5-TP (silvex), a phenoxy herbicide. Silvex is used extensively for forest management by the Bureau's five western Oregon districts.

In March, 1977 the Eugene District Manager's decision that an environmental assessment record adequately reflected environmental impacts of the districts proposed 8,900 acre herbicide program was appealed by a local public group to the Department of Interior Board of Land Appeals. The basis for their appeal was that the use of herbicides represented a potentially significant adverse impact on the human environment. Subsequently, the Oregon State Director recommended the preparation of an environmental impact statement for the proposed Western Oregon Herbicide program. This recommendation was approved by the Acting Director of the Bureau of Land Management and concurred with by the Assistant Secretary, Land and Water Resources.

PROPOSED ACTION

The Bureau proposes to apply herbicides with helicopters, truck mounted systems or with hand held devices on an average of approximately 74,500 acres of forest land annually over the next 10 years (1978 through 1988) to reduce the growth or quantity of vegetation that is:

1) competing for light, soil moisture and soil nutrients with commercial tree seedlings and saplings, 2) clogging up roadside drainage ditches, 3) breaking up asphalt surfacing, 4) obstructing visibility on curves and intersections of forest roads, 5) growing into powerlines, and 6) adversely affecting human health or welfare.

Geographical Location

The Bureau has five district offices in western Oregon. They are located at Salem, Eugene, Roseburg, Coos Bay and Medford (Figure 1). These districts manage approximately 2.4 million acres of public forest land.

TABLE 2

Public Forest Land as of 6/30/76

Salem	403,000 acres
Eugene	317,000 acres
Roseburg	424,000 acres
Medford	910,000 acres
Coos Bay	330,000 acres
Total	2,384,000 acres

U. S. Bureau of Land Management, Western Oregon

Geographic Area

⊙ District Office locations (5)

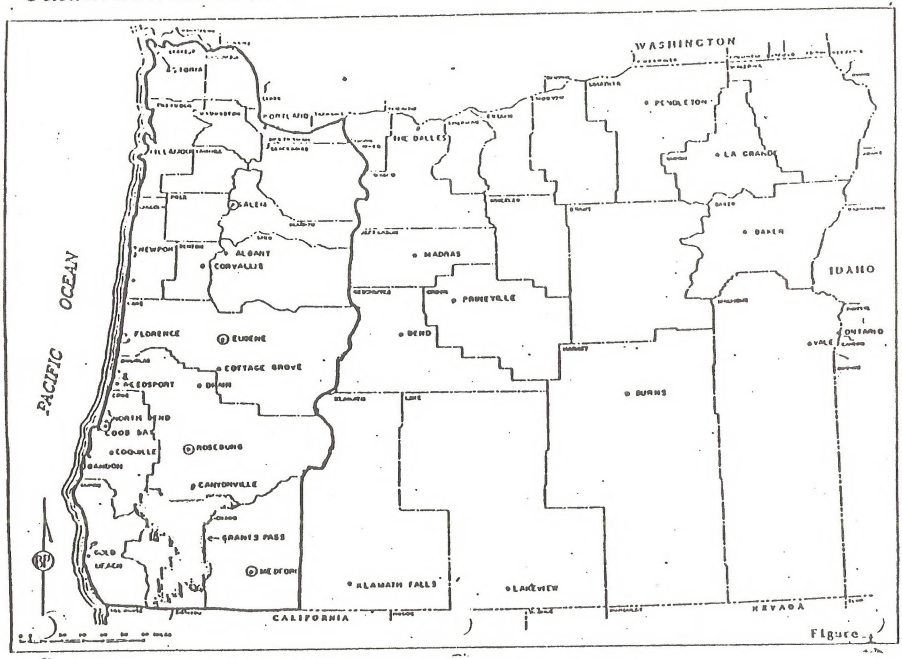


Figure 1

These lands are predominantly characterized by a checkerboard ownership pattern (alternate sections), figure 2, and often surrounded by privately owned tracts. They are located at the lower elevations on the west side of the Cascade Mountains and on both sides of the coast mountain range.

Integrated Existing Vegetation Management Methods

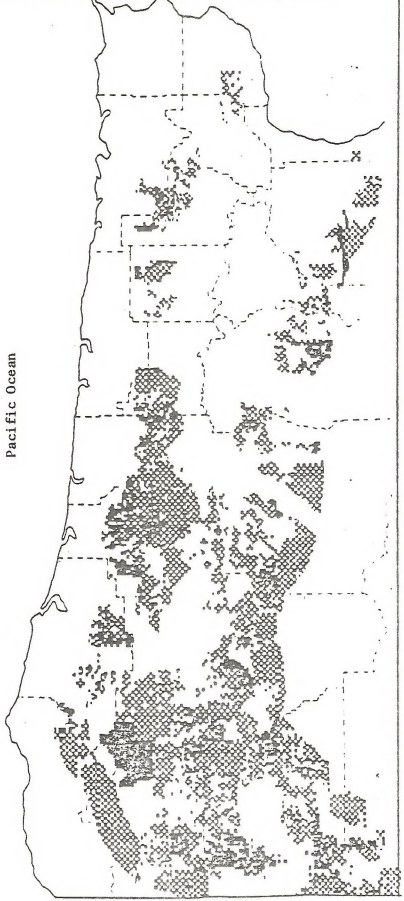
It is important to put vegetation management with herbicides into perspective. Herbicides are not the only tool used by the Bureau to control undesirable vegetative growth in western Oregon.

Vegetation management strategy is developed from Department of Interior guidelines that require a broad spectrum of vegetation control methods in addition to herbicides. These methods include fire, manual, mechanical equipment and biological techniques. These methods are frequently used in combination or supplement each other. Each district has an integrated vegetation management program that is an essential part of its intensive forest management program.

The methods selected for use in one geographic area may not necessarily be the best method(s) in another geographic area. Vegetation management need is analyzed on a tract-by-tract basis. The analysis takes into consideration the management objective for the site, (i.e. timber production, recreation, road maintenance, etc.,) the method with least impact on the environment,

Figure 2

WESTERN OREGON
(Lands administered by the Bureau of Land Management are shown in black: note the checkerboard pattern)



expected effectiveness, operational feasibility, and the cost-effectiveness of the various methods.

As an illustration, a combination of vegetation control methods are used in some projects for controlling hardwoods that will compete with planted trees. On timber sale areas where conifers are the major species, intermingled hardwoods are cut by hand, the stumps are hand treated with herbicides to deter sprouting, and the hardwood slash is burned. In brushfield conversion projects the brush is aerially sprayed, the aerial portion of the plants is allowed to desiccate, and the area is broadcast burned to remove the vegetative residue. In both examples the site is then suitable for planting a new crop of trees.

In the management of encroaching roadside vegetation, control includes the mechanical or manual cutting of roadside brush and the treatment of the cut stumps with herbicides to prevent resprouting; thus, reducing the maintenance frequency.

Dense conifer stands are thinned or conifers mixed with brush and/or hardwoods are treated to reduce vegetative competition by injecting herbicides or by manual cutting of the unwanted vegetation.

Table 3 indicates the acreage proposed for treatment by different methods in 1978. A description of the environmental impacts of non-chemical methods is contained in Chapter VIII, Alternatives to the Proposed Action.

Proposed Uses of Herbicides

Herbicides are used principally to assist in the establishment and growth of forest plantations. Tree planting takes place as soon as possible after the log removal phase of timber harvest. Prompt reforestation is considered important to maintaining a high level of future timber production. Experience has shown that the degree of success in reforestation efforts is directly proportional to the length of lapse time from the date of denudation whether it be from final harvest, fire or other, and the first reforestation effort. The longer the lapse time, the greater the chance for encroachment by competing grass, brush and hardwood species, which in turn requires more intensive site preparation treatments prior to or immediately after tree planting. In some areas, the growth of brush or hardwood trees that takes place after tree planting is so rapid that conifer seedlings initially considered established are overtopped within a few years. In these instances the growth and survival of these seedlings can be significantly reduced from those levels considered essential to a high level of timber production.

Herbicide applications are useful in preparing a site for tree planting and also as a means of releasing oover-topped trees from competing vegetation. Some areas may be subjected to two or three herbicide applications in order to insure the successful establishement of conifers.

Relatively minor but important uses of herbicides include maintenance of roads, power and pipeline rights-of-way and control of noxious plants.

Table 3

Intergrated Vegetation Control Methods - 1978

BLM - Western Oregon

Method	Acres
Controlled burning	12,644
Manual cutting followed with herbicides	2,000
Brown with herbicides and burn	957
Mechanical clearing	2,918
Manual cutting	500
Manual scalping (removing sod around trees)	1,500
Mechanical clearing and burning	1,500
Manual cutting and burning	315
Biological (Cinnabar moth)	(28) releases
Biological (plant large trees)1/	3,720
Mulching around trees	150
Manual thinning	10,000
Mechanical scarification	100
Herbicide application alone	68,534
Total	104,838

1/ These are three year tree seedlings that are generally taller than competing vegetation and are expected to have a growth advantage.

A description of the types of situations where herbicides are used by the Bureau is presented below.

Site Preparation

Site preparation is a practice used to improve plantation success by reducing competition for light, moisture, and soil nutrients prior to or within one year after planting. Site preparation makes it easier to plant or seed an area where the timber has been harvested and gives tree seedlings a much improved chance for survival and rapid growth in the absence or near absence of competitors. Herbicides are used principally to control grass, forbs, and sprouting brush. Brush fields and poorly stocked plantations resulting from plantation failures require brush and hardwood control as a site preparation measure to bring these lands into their full timber production capability. Site preparation treatments with herbicides are proposed on 25,876 acres in 1978 (Table 4).

Release

Release is the reduction of competition for light, moisture, and nutrients between hardwood trees, shrubs or grass and existing conifer seedlings. Fast growing trees, such as red alder or big leaf maple, overtop and suppress slow-starting conifer seedlings. The degree and type of competition varies with the individual site. On dry sites, grass competes effectively for water, while elsewhere, hardwoods grow rapidly enough to shut out essential light and

compete for water during the dry summer periods (Newton 1969). In recent years, herbicides have been used effectively to inhibit the growth of competing vegetation, thereby releasing available water, nutrients, and light to suppressed conifers.

By reducing competition, conifers will grow rapidly beyond the point where they can be overtopped and suppressed by surrounding vegetation (Newton 1969).

Release treatments with herbicides are proposed in 1978 on 45,725 acres (Table 4).

Thinning Conifer Stands

Thinning conifer stands reduces competition and promotes vigorous growth of the best trees. Thinning removes stems of inferior form or quality, excess stems, and the less desirable species. Conifer trees removed are usually those most likely to die from competition. Their early removal allows more rapid growth of desirable trees. One method of thinning is accomplished by injecting herbicides into the unwanted shrubs or trees or by hand spreading herbicides in pellet form around the base of these plants. Thinning treatments with herbicides are proposed in 1978 on 90 acres (Table 4).

Control of Noxious or Poisonous Plants

Oregon has weed control programs designated by law. So the Bureau, being a major landowner, is obligated to cooperate with the state in its weed control programs. A measure of this cooperation is the participation on the Governor's Task Force on Tansy Ragwort Control and the current contract with the Oregon State Department of Agriculture for biological control of tansy ragwort using the Cinnabar moth and Flea beetle.

Control of noxious or poisonous weeds is usually best accomplished by selective spot spraying with herbicides although, mechanical control, hand pulling, and biological control are also used and can be performed in combination with herbicides. Results of biological control on tansy now appears quite promising and may provide the greatest opportunity to combat the effect and spread of this and other noxious and/or poisonous weeds in the future. Control of noxious plants with herbicides is proposed on 200 acres in 1978 (Table 4).

Maintenance of Improvements

Control of encroaching vegetation is part of the routine maintenance of improvements such as roads and rights-of-way. Forest lands are bisected by utility, road and powerline rights-of-way. Tall growing trees and brush species are treated under utility lines to prevent contact of vegetation with

the wires. Selective use of herbicides and mechanical treatment are used to favor a low growing ground cover.

Vegetation in ditches and on shoulders of roads is treated to prevent brush encroachment into the driving lanes, maintain sight distances on curves for the safety of vehicle operators, permit drainage structures to function as intended, and reduce roadway maintenance costs. Herbicides are commonly used singularly or in combination with hand or machine cutting to reduce subsequent sprouting, thereby reducing the frequency and cost of treatment.

Vegetation control projects on recreation and administrative sites are generally used to control or eradicate poisonous plants, such as oak. The use of herbicides for the maintenance of improvements in 1978 is proposed on 2,545 acres (Table 4).

Summary of 1978 Program (Uses)

Table 4 depicts a summary of the total acres proposed for herbicide treatment in 1978 according to use. Maps showing the location of individual project areas and a table containing specific data relating to each area is shown for individual BLM districts in Appendix D.

Table 4

Various Proposed Uses of Herbicides 1978
BLM Western Oregon

Practice	Acres
Site preparation	25,876
Release	45,725
Thinning	90
Control of noxious plants	200
Maintenance of improvements	2,545
Total	74,436

Methods of Application

Herbicides are applied aerially or by several ground application methods. The method selected is dependent on costs, topography, limits of the equipment, kind and dispersion of target plants, potential environmental impacts and biological conditions. These methods are briefly described below.

Aerial

Aerial application makes use of helicopters with positive shutoff spray systems, special drift reduction nozzles and spray mix adjuvants to apply herbicides to target areas. Helicopter application is accomplished under

contract through competitive bidding processes. Most of the herbicides proposed for use in western Oregon are applied by helicopter. In 1978 a total of 62,718 acres or 85 per cent of the area proposed for treatment require helicopter application (Table 5).

Ground

A variety of application methods are available for placement of herbicides from the ground. These include:

Backpack

The backpack system requires an individual to carry on his back either a pressurized sprayer or a powered mist blower. In using either system, herbicide is applied to individual plants or small concentrations of plants. Backpack applications are proposed in 1978 on 5,714 acres (Table 5).

Vehicle Mounted Pressure Spray System

Hand-held spray nozzles or positive placement fixed nozzles attached to trucks are used to treat roadsides and other areas either on an individual plant basis or a broadcast spray basis. Vehicle mounted applications are proposed in 1978 on 1,825 acres (Table 5).

Hand Application

Granular herbicides are placed on the ground over the root system of target vegetation, and liquid herbicides are applied to cut stumps to prevent sprouting.

Cuts are made in the stems of the target plants and the herbicide is injected in the cuts using hand-held containers. Specially developed hatchets with a hollow handle or attachable containers have been developed for this purpose.

Hand applications are proposed in 1978 on 4,179 acres (Table 5).

Summary of 1978 Program (Methods of Herbicide Application)

Table 5 depicts a summary of the total acres proposed for treatment in 1978 according to method. Maps of individual project areas and a table containing specific data relating to each area is shown for individual BLM districts in Appendix D.

Table 5

Methods of Application - 1978
BLM - Western Oregon

Method	Acres
Aerial	62,718
Truck	1,825
Backpack	5,714
Hand	4,179
Total	74,436

Timing of Application

The following information concerning timing of application is quoted from USDA Forest Service General Technical Report, PNW-37, "Silvicultural Use of Herbicides in Pacific Northwest Forests" by H. Gratkowski, 1975.

Stage of plant growth and season of application are especially important in prescribing herbicidal treatments. Chemicals should be applied when unwanted plants are most susceptible and desirable species are relatively resistant or will sustain little damage. All plants exhibit seasonal changes in susceptibility to herbicides. Susceptibility of deciduous species is usually low during dormancy in late fall and winter, but increases from time of bud-break throughout the growing season, and then decreases after growth has ceased. Conifers display similar but even more marked changes of suscep-

tibility, with Douglas-fir, ponderosa pine, and sugar pine showing an increase in resistance to phenoxy herbicides in autumn.

Correct timing in applying herbicidal sprays is essential in releasing young conifers from brush competition. As a result of physiological differences between hardwoods and conifers, many brush species and unwanted hardwood trees are susceptible to herbicidal sprays during periods when conifers are resistant. Successful release of young conifers from brush competition exploits these differences in stages of growth and susceptibility to herbicides. Release sprays are applied when they will produce an acceptable control of competing shrubs with minimum adverse effect to the [illegible]fers.

Damage to conifers due to incorrect timing of herbicidal sprays can vary from deformity or reduced first-year-after-spray growth to complete top-kill of the tree. By maintaining close observation of Plant growth during herbicide spray applications, spraying can be discontinued when it is determined that damage to the conifer will result if spraying is continued. Surveys of planned treatment areas are made to determine that the conifers have ceased growth before aerial herbicide applications commence. By maintaining close observation of the conifers before and during all herbicide operations, damage to them is minimized.

Four periods are suitable for silvicultural aerial application of herbicides in western Oregon. These are, bud-break, early foliar,

late foliar, and late summer. Stump treatments or individual tree injection methods may take place at any time of the year.

Bud-break Sprays

Early spring development of brush species and weed trees does not completely coincide with those of commercially important conifers in Pacific Northwest forests. Weed species generally begin growth and are susceptible to herbicides before bud-break on the conifers.

Bud-break sprays, sometimes called dormant season spraying, to release Douglas-fir, western hemlock, and other conifers are usually applied in February or March after brush species and weed trees begin growth, but before or during bud burst of the conifers. During this period, new leaves are beginning to form on the weed species but absorption of herbicides is primarily through the bark of stems and branches. Most brush species and weed trees are susceptible to herbicides in oil carriers immediately after bud-break while conifers are relatively resistant. As a result, bud-break sprays are one of the most effectfve treatments to release conifers from brush competition. Ponderosa pines in southwest Oregon are an exception; they cannot be released with bud-break sprays. In the Cascade Range in southwestern Oregon, young pines become susceptible to damage from 2,4-D in mid-February, 2 1/2 months before bud elongation signals the beginning of the spring flush of growth. Bud break applications are proposed in 1978 on 51,752 acres (Table 6).

Early Foliar Sprays

Early foliar sprays are applied in April - May after approximately 3/4 of the new leaves on brush species and weed trees are fully developed. All plant species are highly susceptible to herbicides during active growth, and this is one of the most effective periods for application of herbicides for site preparation. For conifer release during this period, sprays must be applied only in water carriers and before new growth on the trees exceeds 1 inch in length. However, sprays at this time are not as effective on deciduous species as late foliar sprays. Early foliar applications are proposed in 1978 on 1,943 acres (Table 6).

Late Foliar Sprays

Late foliar sprays are applied in July and early August after brush species have ceased active growth, all leaves are fully developed and hardened, and terminal buds have been formed. During this period, most brush species are still photosynthetically active and accumulating food reserves, some of which are translocated to root systems for storage. Since phenoxy herbicides move in conjuntion with carbohydrates there can be an effective associated translocation of herbicides to the shrub root systems as well.

Late foliar sprays are not as effective as those applied during the growing season, but this can be an effective season for releasing

conifers from brush competition. Conifer resistance to herbicides increases rapidly after cessation of growth and formation of new buds (Gratkowski 1972). Care must be exercised, however, on wet sites or during rainy periods. Conifers may experience a second flush of growth, again become susceptible to herbicides, and thus be damaged by late foliar sprays. Late foliar sprays are proposed in 1978 on 3,139 acres (Table 6).

Late Summer Sprays

Late summer sprays are applied in late August or very early September, long after brush species and conifers have ceased growth, but at least 1 month before leaf abscission on deciduous species. This is one of the least effective periods for controlling brush species and weed trees with phenoxy herbicides, but control of many species is still sufficient to allow safe and effective release of ponderosa pine.

Late summer has proved the only period in southwest Oregon when Ponderosa pine can be safely released from brush competition with phenoxy herbicides. Ponderosa pine are more sensitive than Douglas-fir to phenoxy herbicides.

Late summer applications are proposed in 1978 on 9,752 acres.

Multi-Seasonal Application

Road maintenance herbicide applications are made at various periods during the year depending on weather conditions, plant species to be controlled and availability of equipment. Rapid invasion of ditches, shoulders and even the running surface principally by hardwood and conifer seedlings is common. Stumps of big leaf maple are treated as soon after cutting as possible. Multi-seasonal applications are proposed in 1978 on 7,860 acres (Table 6).

Table 6 depicts a summary of the total acres proposed for use in 1978 according to season of application. Maps of individual project areas and a table containing specific data relating to each area is shown for individual BLM districts in Appendix D.

Table 6

Season of Application - 1978
BLM - Western Oregon

Season	Acres
Multi Seasonal	7,860
Bud Break	51,752
Early Foliar	1,933
Late Foliar	3,139
Late Summer (includes winter)	9,752
Total	74,436

Selection of Herbicides

Criteria used in the selection of herbicides are based on guidelines and policy issued by the Department of Interior (Appendix A). These criteria are briefly outlined below.

Selection Criteria

1. The chemical proposed for use is not prohibited by the Department of Interior. (See listing in Appendix A).

2. Chemicals on the Department of Interior restricted list (listed in Appendix A) are only used when:

   a) Non-chemical techniques have been considered and found inadequate.

   b) Use can be limited to a relatively small scale application.

3. Use of any chemical is aimed at a specific pest problem and involves minimum strength and frequency of application.

4. Chemical pesticides will not be used alone when non-chemical or integrated chemical and non-chemical techniques offer an environmentally feasible alternative.

5. No pesticide will be used when there is evidence to show that:

   a) Water quality will be degraded.

   b) Hazards exist that will uneccessarily threaten fish, wildlife, their food chain or other components of the natural environment.

6. Herbicides proposed for use must be registered by the Environmental Protection Agency (EPA) according to Public Law 92-516. This law requires a determination by EPA that the chemical "will perform its intended function without unreasonable adverse effects on the environment." If registration of any herbicide is revoked or modified for forest use by the Environmental Protection Agency, use of that herbicide by the Bureau will be terminated or modified accordingly.

Selected Herbicides

Following is a general description of the herbicides proposed for use. More detailed information on the properties of these chemicals is contained in Chapter III and in the Oregon Weed Control Handbook issued each February by the Oregon State University Extension Service at Corvallis, Oregon.

2,4-D

2,4-D is a selective phenoxy herbicide used for site preparation, conifer release, thinning conifer plantations, control of noxious and poisonous plants, and maintenance of improvements. If properly applied, it will not damage conifers when applied aerially as a release spray. It is usually applied at a rate of 1 to 3 pounds per acre.

If plantations of pine are not in a sufficiently dormant stage during the application of 2,4-D the trees will suffer damage. Such damage can occur if unusual summer rains cause pines to continue height growth until midsummer or stimulate a second flush of growth on leaders or laterals during late summer.

Brush control with 2,4-D will generally be sufficient to release ponderosa pine from most shrubs and weed trees. Where moderately resistant shrubs are abundant, however, an additional application of 2,4-D will be needed to maintain dominance of the conifers, (Gratkowski, 1977). Applications of 2,4-D are proposed in 1978 on 38,972 acres (table 1), either alone or in combination with other chemicals.

Silvex

(Trade Names--2,4,5-TP, Kuron, Weedone)

Silvex is a selective herbicide used for site preparation, release, thinning conifers, and controlling poison oak in administrative sites by

ground application. It is a phenoxy herbicide similar to 2,4,5-T or 2,4-D. However, it is potentially more damaging than 2,4,5-T to conifers when used as a release spray. It is normally applied at a rate of 2 to 3 pounds per acre. Applications of Silvex are proposed in 1978 on 42,255 acres (table 1) either alone or in combination with other chemicals.

Atrazine

(Trade names--Aatrex 80w, Aatrex 4L, Atrazine 80w)

Atrazine is a selective herbicide used to release conifers from grass competition, and to prepare grassy sites for tree planting. Application rates are usually at 4 pounds of active ingredient per acre. Atrazine is proposed in 1978 on 14,907 acres (table 1), either alone or on combination with other chemicals.

Dicamba

(Trade name--Banvel)

Dicamba is a non-selective herbicide applied at a rate of 1 to 2 Pounds Per acre. It is used only for site preparation, thinning, noxious weed control, and for right-of-way maintenance. Dicamba is proposed for use in 1978 on 1,721 acres (Table 1) either alone or in combination with other chemicals.

Dalapon
(Trade name--Dowpon M)

Dalapon is a selective herbicide used at rates of 4 to 6 pounds per acre to control perennial grasses in site preparation and maintenance of improvements. Dalapon is proposed for use in 1978 on 6,917 acres (Table 1) either alone or in combination with other chemicals.

Picloram
(Trade name--Tordon)

Tordon is a non-selective herbicide used for site preparation, thinning of conifers, control of noxious or poisonous plants, and maintenance of improvements. It is one of the least toxic herbicides to animals, however it is very toxic to plants. It is used for the control of unwanted trees by injection, applied to the surface of stumps of sprouting species or by spreading pellets over the ground above the root system. It is also used for road maintenance and planting site preparation. Application rates range from 1 to 3 pounds per acre. Tordon is proposed for use in 1978 on 5,266 acres either alone or in combination with other chemicals.

Krenite

Krenite is a new herbicide registered in the State of Oregon for site preparation and release on forest lands. It is applied at a rate of 3 to 5

pounds per acre to control deciduous woody plants and certain noxious or poisonous weeds and to maintain improvements. It can be used for "trimming" by treating only those parts of the plant needing control. For instance, branches overhanging a right-of-way clearing can be sprayed without killing the entire tree. Other herbicides or treatment methods must still be used for site preparation in brush communities where evergreen shrubs such as ceanothus require control because Krenite is not effective against evergreens (Gratkowski et al., 1977). Krenite is proposed for use in 1978 on 2,481 acres (Table 1).

Diuron

(Trade name--Karmex)

Diuron is a soil sterilant that is mixed with water and used in the maintenance of road shoulders and ditches. It is applied at rates of 3 to 32 pounds per acre. Diuron is proposed for use in 1978 on 580 acres (table 1).

Simazine

(Trade name--Princep)

Simazine is used to control certain grasses. It is used for site Preparation and road maintenance. Application rates are similar to those of Diuron. Simazine is proposed for use in 1978 on 200 acres (Table 1).

Glyphosate

(Round-up)

Round-up is a new chemical recently registered in Oregon for forestry use. It can be used to control annual and perennial weeds and certain brush species. However it is not effective against evergreen plant species such as Ceanothus or Madrone.

Round-up is applied at rates of 1 quart to 1 gallon per acre.

Round-up appears to be more effective than Silvex where deciduous brush species are the primary target. No areas are proposed for treatment with Round-up in 1978 because the chemical has just recently been registered for forestry use. However, it is proposed for use on 12,887 acres in 1979.

Combinations

Combinations of herbicides are used as recommended by knowledgeable scientists. Combinations permit a broader range of effectiveness when several target species such as brush, hardwood trees and grass exist on a treatment area. Specific combinations proposed for 1978 are shown in Table 7. This table also contains a projection of the acreage proposed for treatment during the decade.

Table 7

Proposed and Projected Herbicide Program 1978 through 1987

Herbicide	Target Species	1978	1979	1978-1987 Cumulative (Acres)
Silvex	Madrone, Maple Ceanothus	9,207	5,550	55,500
Silvex + 2,4-D	Alder, Vine Maple, Madrone, Hazel	32,800	16,165	161,000
Banvel 520 + 2,4-D	Bigleaf Maple, Chinkapin Oak	222	250	2,500
Banvel 520	Bigleaf Maple	1,124	2,150	2,150
Tordon 101	Bigleaf Maple	2,822	3,302	3,300
Tordon 10K	Bigleaf Maple	9	10	100
Diuron	Grasses, Forbs	580	518	5,000
Dicamba + 2,4-D	Alder, Maple	375	376	3,800
Krenite	Alder, Maple, Cherry, Willow	2,481	8,525	85,000
Tordon 101R	Bigleaf Maple	1,630	1,150	11,500
Tordon K + Verton 2-D	Tanoak, Maple, Salmonberry	805	600	6,000
Weedone 170	Madrone, Willow	40	10	100
Banvel 720	Alder, Vine Maple		150	1,500
Simazine	Grasses, Forbs	200		2,000
Atrazine	Annual Grasses	8,592	5,631	56,000
Atrazine + Dowpon (Dalapon)	Annual and perennial Grasses	3,865	5,690	57,000
Atrazine + 2,4-D	Grasses, Thistle	1,436	1,300	13,000

Table 7 (concluded)

Herbicide	Target Species	1978	1979	1978-1987 Cumulative (Acres)
Atrazine + 2,4-D + Dalapon	Grasses, Broad-leafed weeds	1,014	1,150	11,500
Dowpon (Dalapon)	Annual, perennial Grasses	2,100	1,700	17,000
2,4-D Round-up	Alder, Tansy Ragwort	5,134	7,664	77,000
Round-up	Hazel, Elderberry Vine Maple, Salmonberry, Thimbelberry		12,526	125,500
Total		74,436	74,417	745,000

Herbicide Carriers

Water is usually the carrier for herbicides, but in some cases other carriers are used. Diesel oil, one of the principal carriers used with forest herbicides, may constitute up to 95 percent of the spray solution volume. During dormant season applications, the diesel oil constitutes most of the spray solution and serves two purposes: (1) it dilutes the herbicide and thus allows for more effective application, and (2) it helps the herbicide penetrate bark, thus carrying the herbicide into the plant. Dormant season aerial applications may use as much as 15 gallons of diesel oil per acre. An estimated 180,000 gallons are proposed for use in 1978. During the growing season most formulations use a small amount of diesel oil to dilute the herbicide. The resulting solution is emulsified in water for spraying. Growing season applications apply 0.5 to 1.0 gallons of diesel oil per acre.

Herbicide carriers proposed for use in 1978 are shown in appendix D for each proposed treatment.

Controls and Safety in the Use of Herbicides

Departmental and Bureau policy is summarized below. Applicators will be required to take steps to minimize chemical drift, assure proper application rates, and avoid or minimize contamination of non-target components of the environment such as streams.

Policy and Law

1. Environmental impacts will be identified, through an environmental assessment and measures taken to mitigate potentially adverse environmental impacts.

2. Programs will be reviewed with user groups, interested organizations and the general public.

3. Only federally registered pesticides will be used on Public Lands except as authorized by Sec. 24.c, Public Law 92-516, The Federal Environmental Pesticide Control Act of 1972. Section 24c provides for State registration of certain pesticides for local needs within the State. Any pesticide proposal planned under a State registration must include a copy of the State label.

4. Tank mixes of pesticides may be approved if: such mixture is provided for on one or more labels of EPA registered products; provided for under a State registration, or if the tank mix has been tested and has a written recommendation by an Agricultural Experiment Station or the State Department of Agriculture. The pesticides recommended in the mixture must be applied at a dosage rate not to exceed the label instructions for use of any single product for the same target pest and must not be specifically prohibited from mixing on either label. Each tank mix proposal must be accompanied by appropriate labels and/or a written recommendation.

5. On May 5, 1975, EPA announced the initiation of the Pesticide Enforcement Policy Statements (PEPS) series. These statements are published in the Federal Register and are intended to clarify EPA's policy regarding the enforcement of the Federal Insecticide, Fungicide and Rodenticide Act.

PEP No. 1, published May 5, 1975, and September 17, 1975, allows for the use of a registered pesticide at less than the label dosage if such use is recommended in writing by a knowledgeable expert.

6. Integrated pest control methods which may combine chemical, manual, mechanical or biological control techniques will be used where they minimize the adverse impact of pest control.

7. All proposed use of herbicides on Public lands will be reviewed for approval in advance by the Bureau's Denver Service Center and/or Washington, D.C. office.

8. Federal and State agencies such as the Oregon DEQ and the State Department of Agiculture with responsibilities for the environment, public health, and fish and wildlife, will be informed of programs and cooperative measures developed when necessary.

9. Only properly trained and/or licensed personnel will handle and use herbicides on public lands. This includes applications by

permitees, grantees, or licensees. At least one member of the crew, preferably the on-the-ground supervisor, must be a qualified applicator.

10. All individuals associated with the handling or application of herbicides on public lands will be familiar with emergency procedures to be used in case of a herbicide spill.

11. Water monitoring of important streams will be done when there is a possibility that contamination may result from a proposed herbicide use.

Project Design Features

Specific measures are included in the design of each proposed herbicide project in order to minimize adverse impacts on the environment. They include the following:

1. Any specific BLM proposed herbicide project will be preceded by a preliminary archeological survey. An evaluation of the findings will determine whether there are sites of value and whether they should be salvaged by removal, or left and circumvented by the project.

2. BLM projects possibly affecting areas of historical value will be preceded by a search through the cultural and historical sites listings currently on file with and soon to be published by the State Parks Department.

3. Herbicides will be used during off season in recreation areas to control poisonous plants. These herbicide applications will be made early in the spring or late in the fall prior to or after maximum recreation use.

4. The process of locating, identifying, and managing significant concentrations of rare and endangered plants is in a developmental stage. The Federal Register of July 1, 1975 (Vol. 40, No. 127) contains a comprehensive list of candidate endangered or threatened plants compiled by the Smithsonian Institution and submitted to the Department of the Interior as provided for by the Endangered Species Act of 1973. In addition a tentative list of plants that are proposed for inclusion on the Federal list of threatened or endangered species is available upon request (32 pages). If these plants are known or suspected to occur within the influence zone of the proposed action, an on-the-ground floristic inventory will be made. The proposed action will be modified to protect these plants if they are threatened by the proposed action.

5. On herbicide application projects conducted directly by Bureau Personnel, a licensed employee will monitor and supervise the project. Work done by contractors will be carried out by individuals having proper State licenses.

6. Contracts for application will require that the intake operation of water for mixing shall be arranged so that an air gap or reservoir will be placed between the live water intake and the mixing tank to prevent any backflow of chemical into the water source.

7. Contracts for application will require that contractors will not wash out any spray tanks in or near any streams or dispose of any chemical containers on the contract area.

8. During aerial spraying, spray will be turned off at the end of spray runs and during the time when a turn is being made to start another spray run. Initial spray swaths along buffer strips or other areas to be protected will be made parallel to these areas and before spraying commences on the rest of the project area.

9. Mixing and loading operations will take place in an area where an accidental spill will not flow into a stream or body of water.

10. The following are minimum widths (measured horizontally) for unsprayed buffer strips for all herbicides (except Silvex and Tordon) applied adjacent to "waters which are valuable for domestic use, are important for angling or other recreation and/or used by significant numbers of fish for spawning, rearing or migration routes (Class I streams) bodies of water, or marshy areas. Buffer strip widths for headwater streams and minor drainages (class II streams) are discretionary.

a.) Aerial Spraying

Spraying Altitude (over ground)	Buffer Strip
30-45 feet	100 feet
b.) Vehicle spraying	25 feet
c.) Hand application	10 feet

11. The foregoing buffer strip widths will be doubled as a minimum and will be required for both class I and II streams in or adjacent to project areas planned for treatment with Silvex.

12. Based upon the recommendations of the Working Group on Pest Management of the President's Council on Environmental Quality, an untreated buffer strip of at least 100 feet will be left adjacent to all streams and bodies of water when either Dicamba or Tordon 101 are used regardless of the application method.

13. To minimize drift and volatilization, aerial applications of all the herbicides proposed for use will be confined to periods when wind speed is less than 6 miles per hour, air temperature is under 70°F., relative humidity is over 50 percent, vegetation is free of snow or ice, precipitation is not occurring or imminent, and air turbulence will not affect normal spray patterns. Label directions will be followed if they require additional restrictions. Low volatile ester formulations of 2,4-D and Silvex will be used.

14. Daily measurements of weather conditions will be made by trained personnel at spray sites during application. Additional measurements will be made anytime it appears that a weather change may be taking place that could jeopardize safe placement of the spray on the target area.

15. The helicopters will normally be required to fly at an airspeed of 40 to 50 mph. at 30 to 45 feet above the vegetation. Spray pressure in the boom will be 25 to 35 pounds per square inch. Maximum drift reduction with normal spray formulations and conventional application equipment will be obtained by using D8 jet nozzles (8/64 inch diameter orifice) directed back along the airstream (Stewart, 1976). All aerial nozzles will be equipped with automatic shutoff devices to prevent loss of herbicide along nonspray flight routes. Spray mixtures will contain drift reduction adjuvants where they will be effective.

16. During air operations a radio network will be maintained which links all parts of the project. Direct radio communications between spray aircraft and ground observers will be established. Prespray recconaissance flights will be made to orient pilots when sensitive areas such as agricultural lands are adjoining spray targets.

17. Application of atrazine, 2,4-D, Tordon, Silvex, Dicamba, Dalapon, Krenite, Diuron, Simazine and Roundup with vehicle mounted pressure sprayers or backpack equipment will involve many of the same controls used with aerial operations. Specific applications proposed for 1978 are shown in Appendix D.

Application will be in strict conformity to label instructions. Each applicator will be trained in the correct operation of spray equipment, prevention of plumbing leaks, safe handling and mixing of herbicides, control of application rate and will be supervised by licensed personnel. Radio communication will be maintained with any vehicle transporting or spraying herbicide.

Monitoring Environmental Impacts

The overall responsibility for monitoring environmental impacts of chemical herbicides rests with the Environmental Protection Agency (P.L. 92-516, Sec. 20). Currently, EPA has a nation wide Dioxin (TCDD) monitoring plan in operation. Precise identification of the minute quantities involved and the interpretation of the findings requires the highly sophisticated research techniques and methodologies of research organizations. The Bureau's research needs are met by published research results from research agencies and by contracting for research when existing or planned research is judged inadequate.

Research on environmental impacts of herbicides to animals, water, soil, and plants is conducted by chemical companies as a prerequisite to registration with the Environmental Protection Agency. Additional research is conducted by Federal agencies and universities. The Bureau will keep abreast of these research findings and, where indicated by research results and EPA recommendations, adjust its proposed herbicide applications.

A water monitoring program will be carried out by the Bureau as part of the proposed action. The purpose is to determine the effectiveness of buffer strips, and administrative controls in protecting water quality and the aquatic environment. The guidelines for when to monitor water are listed below. Specific details of monitoring procedures are contained in Appendix B.

1. Water monitoring will be done when any herbicide application is in a municipal watershed.

2. Water monitoring will be done when any herbicide application is located in a fish hatchery supply watershed.

3. Water monitoring will be done when any herbicide application is in a watershed with a domestic water supply intake for drinking or irrigation less than one mile downstream from the treatment area.

4. Water monitoring will be done where a herbicide application is ajacent to or the treatment area includes a major fish bearing stream.

Safeguards

The safe use of herbicides includes precautionary measures to prevent accidental spills. The following written precautions describe the measures

that will be used to reduce the chance of such accidents, and the emergency action required if an accidental spill should occur.

The applicable Federal regulations concerning the storage and disposal of herbicides and herbicide containers will be followed. These are described in the Environmental Protection Agency "Regulations for Acceptance and Procedures for Disposal and Storage", Federal Register May 1, 1974, pages 15236 through 15241.

Transportation

1. It is essential to prevent damage to containers so that leaks do not develop, care will be exercised so that the containers are not punctured or ruptured, and so that the lids or caps are not loosened.

2. Precautions will be taken in the loading and stacking of herbicide containers on the transporting vehicle to assure that containers are tied down so that they will not fall as the vehicle moves.

3. Open containers will never be transported. Partly empty containers must be securely re-sealed before transport.

4. After transportation, all herbicide containers will be inspected for damage and leaks, and the vehicle should be carefully examined for contamination.

Application Safety

1. Arrange spraying schedules so that poor visibility before and shortly after sunrise and sunset will not seriously affect the safety of the pilot.

2. Do not permit uphill spraying when the climb required exceeds one-half the climbing ability of the helicopter.

3. Allow spraying from a higher altitude where steep canyonheads, snags, or standing timber in the spray area make it hazardous to spray at the specified contract heights.

4. Allow sufficient elevation to be gained by the pilot at the lower open end of drainages after a spraying run to eliminate the need to climb in returning for another spray run.

5. Allow the contractor's chief pilot to establish a pattern to avoid danger of collision when pilots spray adjoining blocks concurrently.

6. Instruct pilot to stop spraying when in his own judgment conditions are too hazardous.

7. Fly at a height above the ground that will produce effective treatment results. In no case should the minimum flight height be less than 30 feet.

8. Caution pilots about dangers such as lone snags and trees, and location of downdrafts. Review project maps with each pilot, paying particular attention to heliports, areas being sprayed, and approaches to and from those areas.

9. Caution pilots as to the location of telephone and electric lines near any heliport which will be used. Mark telephone and electric lines with highly visible material if it can be done safely.

10. If a helicopter crashes check the pilot's clothing to see if he has been splashed with herbicide. If so, and if he is not seriously injured, help him wash several times with soap.

11. When an injured pilot is taken to a hospital or doctor, make certain they know the pilot has been exposed to a herbicide and provide any herbicide label information that is available.

12. When applying chemicals by hand, all new crew members will receive orientation on the reason for the use of the chemical; the proper handling and application of the chemical, and the care of applicators and hatchets.

Tanker Precautions

1. All valves capable of emptying the tanker will be lockable.

2. An air gap or reservoir between the water source and the mixing tank is required. A separate portable pump may be used.

3. Mixing of spray solutions must be done away from streams, drains, or ditches leading to streams where spills would reach a stream if they occurred.

4. Plan the movement of loaded herbicide tankers so as to minimize travel adjacent to streams.

Spills

In the event of a spill the project inspector or crew foreman will immediately implement measures to contain the herbicide. The following individuals will be notified as soon as possible: (1) the area manager, (2) the district manager, (3) the State Office Pesticide-Use Coordinator (931.3), and (4) the Oregon State Department of Agriculture, pesticide regulation division.

1. Contain herbicides by diking and collecting pools. Know the availability of earth moving equipment close to the project.

2. The Environmental Protection Agency will be notified immediately if a major spill occurs. The emergency number to call is (206) 442-1200. For additional assistance call the Pesticide Safety Team Network (513) 961-4300.

3. Inspect surrounding area for possible contamination.

Interrelationships

The use of herbicides for vegetation control has been previously described in the Bureau's programmatic 1975 Timber Management Environmental Statement and is further described for individual planning units within each district as a result of Bureau planning system procedures. The relationship between the proposed program, published timber management environmental statements and the Bureau planning system is discussed in the succeeding paragraphs.

Environmental Statements

The proposed herbicide program is one action plan component of the Bureau's Timber Management Program. The bureau-wide timber program is described in detail in the Final Environmental Statement for Timber Management prepared in 1975. Herbicide use is described in section I.E. page 36.

More localized environmental statements describing timber management for each of the Bureau's western Oregon eleven sustained yield units are now being developed. They are scheduled for completion by July 1, 1982. Table 7 lists the ES completion dates for each sustained yield unit. Proposed herbicide use will be described in each of these statements as one phase of the many proposed timber management activities.

Table 8

Schedule for Final Environmental Statements for Western Oregon Susained-Yield Timber Management Units

Sustained-Yield Unit	Completion Date for Final EIS	District
Joesphine	April 1, 1978	Medford
Jackson	July 1, 1979	Medford
Klamath	July 1, 1979	Medfod
South Coast	July 1, 1980	Coos Bay
Curry	July 1, 1980	Coos Bay
Clackamas-Molalla-Santiam	July 1, 1981	Salem
Alsea-Rickreall-Columbia	July 1, 1981	Salem
South Umpqua	July 1, 1982	Roseburg
Douglas	July 1, 1982	Roseburg
Siusalw	July 1, 1982	Eugene
Upper Willamette	July 1, 1982	Eugene

Bureau Planning System

The timber management environmental statements mentioned previously and proposed herbicide use described therein will flow from processes required by the Bureau Planning System. This system is described briefly in the succeeding paragraphs.

Purpose

- Permit informed and objective multiple-use decisions through the identification and reconciliation of conflicting land and resource uses in advance of on-the-ground action.

- Help insure that land and resource use, development and management plans and program decisions are responsive to Congressional, Departmental, and Bureau objectives.

The Bureau Planning System is designed to be used in the preparation and maintenance of land-use plans (multiple use) for public lands under BLM administration. These plans, called Management Framework Plans (MFP's), establish coordination between the seven basic resource values or activities for which public lands are managed. These activities include minerals, wildlife habitat, livestock forage, watershed, timber, recreation and intensive land use (e.g., rights-of-way, urban commercial, etc.).

Processes

Management framework plans are prepared and maintained by an interdisciplinary staff in each of the five BLM western Oregon districts. The plans are being recorded for approximately 11 planning units. The system was first started in 1969 and, as of the end of fiscal year 1974, first generation plans were completed for all 11 of the planning units of western Oregon. Second generation plans are now in progress. The forest land identified for timber production through this process is the principal area where the proposed herbicide projects are planned.

In consultation with a variety of public groups, the BLM planning team pulls together all public input including land-use and resource trade-offs. BLM's objective is to ensure that all concerned and interested citizens, either individually or in organized groups, have an opportunity to fully understand the values of the public lands and related alternate uses, and then have an opportunity to contribute their ideas, knowledge, and proposals in the planning process. This results in a wide variety of meetings and consultations, tailored to the needs of the public involved. In developing the current program, for example, the Bureau invited interested groups, institutions, organizations and individuals to attend and participate in public meetings on its Management Framework Plans. Based on the comments derived through these meetings, planning documents and, consequently, proposed land-use decisions were revised, as necessary, to reflect the public input. As existing land-use plans are updated or new plans are developed, more

detailed, sophisticated, and intensive public participation plans will be utilized to assure maximum public involvement in the Bureau planning process.

Environmental Assessment

A great deal of environmental assessment occurs in the preparation of Management Framework Plans (MFP). However, there are many situations such as the proposed herbicide program where more detailed and specific assessments are needed to consider alternate action proposals directed at the goals which are set forth within the framework of the MFP. The environmental assessment is especially important in situations where a Management Framework Plan has not yet been prepared, or where data have changed and the MFP has not yet been revised.

Reforestation Program

Twenty-three million trees consisting of one, two, and three-year-old trees are scheduled to be planted on timber harvest areas in western Oregon in 1978. A tree planting program that ranges between 20,000 and 40,000 acres is scheduled annually. Seedling survival and growth is directly dependent on the management of competing vegetation as described in preceding portions of this chapter. These trees were grown in bare root seedling nurseries and greenhouses at a cost of 1.3 million dollars. Planting these trees in 1978 is expected to cost about 1.5 million dollars.

State and Private Company Programs

Herbicide programs similar to those prepared by the Bureau are conducted by the State Forestry Department and private timber companies for the same purpose. Herbicides used are applied at similar rates, seasons of the year and methods of application. They differ from the Bureau in that 2,4,5-T, and Amitrole-T forumulations that are registered with EPA for forestry uses are used for vegetation control whereas use of these herbicides by the Bureau is prohibited by Department of Interior policy. The magnitude of these herbicides programs varies from year to year. However, it is estimated that the average annual usage is on less than 2 percent (100,000 acres) of the forest land base of these organizations.

U.S. Forest Service

Environmental assessment information generated by the U.S. Forest Service (Region 6, Pacific Northwest) in their 1978 environmental impact statement on vegetation management with herbicides has been used extensively in preparing this document. Their objectives and methods are very similar to those of the Bureau. The total area proposed for treatment in western Oregon by the U.S. Forest Service in 1978 is approximately 90,000 acres. The U.S. Forest program differs from the Bureau in that registered herbicides prohibited by the Department of the Interior as shown on the list in Appendix A are available and in use where judged appropriate by the Forest Service.

Required Actions

Prior to implementation of the proposed program the Bureau is required to submit herbicide projects that propose the use of Department of Interior restricted herbicides (Appendix A) or treat an area over 640 acres in size to a Department of Interior review group for its approval.

There are no other Federal, State or local actions that are required to implement the program.

CHAPTER II

DESCRIPTION OF THE EXISTING ENVIRONMENT

The descriptive material in this chapter has been adapted from the Final Environmental Statement, Timber Management, BLM 1975, the 1974 Programmatic Environmental Assessment Record for the Bureau's Western Oregon Timber Management Program, and other sources. The purpose is to describe the components of the existing environment that may be significantly impacted by the proposed action as described in Chapter I.

There are three major biomes found in western Oregon; namely the Coniferous Forest, Grassland, and Woodland-Bushland. The grassland biome is non-forest in character and is not addressed in this statement.

The Coniferous Forest Biome in western Oregon is further subdivided into the Northwest Coastal Coniferous Forest sub-biome and the Montane Forest sub-biomes. The Woodland-Bushland Biome is represented by the Broad Sclerophyll sub-biome. These three sub-biomes form the major ecological types found in the areas proposed for herbicide treatment.

Although precise boundaries between biomes and sub-biomes are not distinguishable in the field, they are employed in this statement in order to utilize the information that is known about them. Within this framework, the environmental components of each biome that have the highest probability of

being affected by herbicide use are described. These are; terrestrial vegetation, terrestrial wildlife, soil, aquatic organisms, water, visual resources and man.

The geographic locations of the sub-biomes that are involved in the proposed action are shown in figure 3 and described in the following paragraphs.

Northwest Coastal Coniferous Forest (Sub-biome 1)

This forest extends from the northern to the southern border of western Oregon. The crest of the Cascade Mountains marks the eastern reach of the Coast Forest, and the Pacific Ocean bounds the western reach. At approximately 43 degrees N latitude, the Coastal Forest constricts to a narrow band along the west slope of the southern Oregon Siskiyou and Coast Range Mountains.

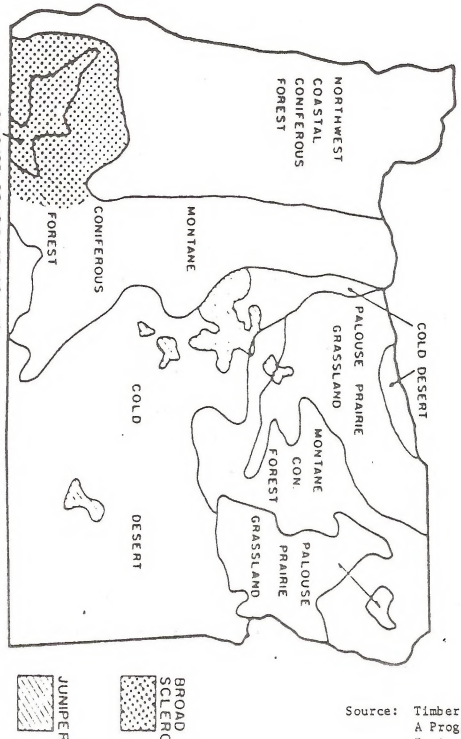
Montane Coniferous Forest (Sub-biome 2)

That portion of the Montane Forest involved in the proposed action is located in southwestern Oregon, generally ranging south from 43 degrees N latitude to the California border, and extending west from the line between Ranges 8 and 9 East to the summit of the Coast Range.

Figure 3

OREGON

SUB-BIOME MAP



Source: Timber Management, A Programmatic Environmental Analysis Report for Western Oregon, 1974 (BLM).

Broad Sclerophyll (Sub-biome 3)

The Broad Sclerophyll sub-biome occurs as biological islands within the southwestern part of the Montane Forest.

TERRESTRIAL VEGETATION

Generally speaking, western Oregon is dominated by coniferous forests, interrupted by the Willamette, Umpqua and Rogue River Valleys.

The following description addresses the major non-agricultural vegetative conditions such as forest zones, wherein a single tree species or a few species compose the climax. Each forest zone or vegetative type described has within its boundary other kinds of vegetation limited to a very small proportion of the total land area. Oak (Quercus) - grass types scattered throughout the coniferous forest is one example. Another is riparian, or streamside, vegetation which forms a network throughout all sub-biomes. Riparian vegetation varies considerably and may include red alder (*Alnus rubra*), black cottonwood (*Populus trichocarpa*), big leaf maple (*Acer macrophyllum*), and where annual flooding occurs, willow (*Salix* spp.). Where streams are normally confined to their banks such vegetation is more typical of the forest zone, or other vegetative within which it lies. A further description of riparian vegetation is presented in the subsequent discussion of the aquatic environment.

Herbicides used in silviculture are used to treat plants at certain successional stages in each of the sub-biomes (see table 1, Chapter I). Some forest ecosystems contain introduced plants whose invasion may have resulted in changes in the natural forest succession. The existing vegetation is representative of commercial forest land on which the distribution and abundance of the various seral stages has been extensively changed by man's logging activity. Conversion of forest lands to agricultural and residential use has resulted in agricultural crops being in proximity to potential spray units. Vegetation associated with agricultural land or residential areas occurs within 1 mile of proposed project areas in 188 cases out of the 1,836 project areas proposed in 1978. The locations of these 188 areas are shown on the project maps in Appendix D. Vegetation on these areas may be hay, row crops, grass, or orchards. Roadside vegetation control may be in any vegetation type but is usually in early seral vegetation which has invaded disturbed ground.

Federally listed threatened or endangered plant species are proposed and not yet officially listed. They may occur in any of these vegetation types. A tentative list of those species is available upon request.

Broad Sclerophyll

This sub-biome exists as scattered or interrupted areas in southwestern Oregon where sclerophyllus species (species with broad, evergreen leaves) predominate.

Some sclerophyll communities are climax while others occur as seral (transitory) vegetation following fire or logging. Such communities normally occur on the dryer (xeric) sites typical of the Umpqua or Rogue River Valley, on shallow soils on southerly exposures at higher elevations, or on areas of low rainfall.

It is difficult to tell from vegetation alone where a community on a given site is climax or seral (transitory). BLM has classified land occupied by sclerophyll vegetation into timber producing and non-timber producing forest land based on soil, aspect, elevation, land treatment history, and other factors.

Timber producing forest land is land clearly capable of producing at least 20 cubic feet per acre per year of commercial timber species. Spray operations for release or conversion only occur on these lands. The 1978 proposed herbicide program identifies 45,725 acres for release. Convertible sclerophyll vegetation types that are not coniferous at present are properly considered under the Montane Coniferous Forest sub-biome, since conifers are the climax association there. Spray operations in seral sclerophyll communities are aimed at reducing most or all of the sclerophyll vegetation in competition with conifers.

Vegetation common to the broad sclerophyll sub-biome may include the following broadleaf evergreen trees and shrubs (typical sclerophyllus), and deciduous species to a lesser degree:

Evergreens (Sclerophyllus)

Tanoak (Lithocarpus densiflorus)

Chinkapin (Castanopsis chrysophylls)

Canyon Live Oak (Quercus chrysolepis)

Pacific Madrone (Arbutus menziesii)

Narrow-Leaf Buckthorn (Ceanothus cuneatus)

Snowbrush or Varnishleaf (C. veluntinus)

Pine Mat Manzanita (Arctostophylos nevadensis)

Hoary Manzanita (A. canescens)

California Coffee Berry (Rhamnus californica)

Birchleaf Mountain Mohogany (Cereocarpus betuloides)

Deciduous

Oregon White Oak (Quercus garryana)

California Black Oak (Q. kelloggii)

Redstem Ceanothus (Ceanothus sanguineus)

Deerbrush Ceanothus (C. integerrimus)

Pale Serviceberry (Amelanchier pallida)

Skunkbrush Sumac (Rhus trilobata)

Poison Oak (Rhus diversiloba)

Northwest Coastal Coniferous Forest

This is the most densely forested of the three coniferous forest sub-biomes. After cutting forests may regenerate easily, but competing vegetation

and animals may seriously impede the rate of conifer establishment and growth. When free to grow, conifers grow rapidly and reach impressive sizes quickly. The lower vegetative layers are usually poorly developed except where open canopies encourage growth of a lush understory of shrub and herbaceous layers. Brush communities tend to be multistoried with dense salmonberry and fern vegetation under an overstory of alder. Franklin and Dyrness have identified five major vegetative (climax) zones within the sub-biome that are dominated by coniferous vegetation. Three of these occur on BLM land. They include (1) the coastal "Sitka spruce zone" (2) the widespread inland low to mid-elevational "Western hemlock zone" (3) the higher elevational "Pacific silver fir zone". These vegetation zones reflect climatic and elevational differences that occur through the sub-biome.

Major tree species and their occurrence within the major zones are estimated in table 9.

The cool-moist, warm-dry dichotomy relates to plant succession following removal of the coniferous forest. There is a tendency towards development of dense, semi-permanent shrub and hardwood communities that exclude or limit conifers on relatively cool-moist sites within the Sitka Spruce Zone. On relatively warm-dry sites in the Western Hemlock zone, however, the tendency is towards exclusion of conifers during a period of dominance by herbaceous plants, especially following clearcutting and burning.

Table 9 - Northwest Coastal Sub-Biome
Major Species Occurrence by Zones 1/

Species	Sitka Spruce	Western Hemlock	Pacific Silver Fir
Western White Pine (*Pinus monticola*)	4	3	2
Sugar Pine (*Pinus lambertiana*)	4	3	3
Whitebark Pine (*Pinus albicaulis*)	4	4	4
Lodgepole Pine (*Pinus contorta*)	1	4	2
Ponderosa Pine (*Pinus ponderosa*)	4	4	4
Western Larch (*Larix occidentalis*)	4	4	3
Englemann Spruce (*Picea engelmannii*)	4	4	2
Sitka Spruce (*Picea sitchensis*)	2	3	4
Western Hemlock (*Tsuga heterophylla*)	1	1	2
Mountain Hemlock (*Tsuga mertensiana*)	4	4	2
Douglas Fir (*Pseudotsuga menziesii*)	1	1	2
Grand Fir (*Abies grandis*)	2	2	3
Pacific Silver Fir (*Abies amabilis*)	4	3	1
White Fir (*Abies concolor*)	4	4	4
Noble Fir (*Abies procera*)	4	3	2
Shasta Red Fir (*Abies magnifica*)	4	4	3
Subalpine Fir (*Abies lasiocarpa*)	4	4	2
Redwood (*Sequoia serpervirens*)	2	4	4
Incense Cedar (*Libocedrus decurrens*)	3	2	3
Western Redcedar (*Thuja plicata*)	2	2	3

1/ 1 = abundant, 2 = common, 3 = uncommon, 4 = rare or absent.

Plant succession following removal of forest vegetation usually proceeds through three stages; (1) rapid growth of residual and invading herbaceous plants (such as grasses and ferns), and (2) gradual development into a shrub dominated condition, and (3) development of the young growth forest. Stages one or two, or both, may not occur depending upon environmental factors. Either of the first two stages may also dominate for long periods of time, also due to environmental factors.

It is not practical to exactly quantify the number of acres in each seral stage at any particular time. BLM, through field surveys maintains a record of timber types in existence and recommended treatments for tracts. Individual survey units may contain one or more seral stages. Plants commonly controlled with herbicides in this sub-biome are shown in table 10. The specific herbicides used for this purpose are shown on table 1 in Chapter I.

Montane Coniferous Forest

Forests of this sub-biome generally grow more slowly than coastal forests, but are still highly productive. Forests may regenerate easily or with difficulty depending on aspect, soil moisture holding capacity, elevation, rainfall, or herbaceous competition. Stands may be relatively uneven aged, especially on hot aspects. The understory tends to have sparse shrub or herbaceous layers, but may also be dense. Plant succession following removal of the forest in this sub-biome usually follows the three stages outlined for

Table 10 - Northwest Coastal Sub-Biome Important Competitor Plant Occurrence by Zone

Plant	Sitka Spruce	Western Hemlock	Pacific Silver Fir
Annual Grass	2	2	4
Red Alder	1	2	4
Vine Maple	1	2	2
Hazel	1	2	4
Salmonberry	1	3	4
Thimbleberry	1	3	4
Blackberry	2	2	4
Willow	1	2	4
Bigleaf Maple	1	2	4
Bittercherry	2	4	4
Sword Fern	1	3	4
Chinkapin	3	2	4
Ceanothus	3	2	3

1 = abundant
2 = common
3 = uncommon
4 = rare or absent

the Northwest Coastal Coniferous Forests; i.e., herbs, to shrubs, to conifers. Also as in the Northwest Coastal Coniferous Forest, one or both of the first two stages may not occur on any given area, or may persist for an exceedingly long period of time.

This region may be viewed as having six major forest zones which reflect climatic and elevational differences. Four of these are found on BLM land. They are (1) mixed evergreen, (2) mixed conifer, (3) white fir, and (4) red fir. The mixed evergreen and mixed conifer are successionally similar and are considered together. The lower zones, the mixed conifer and mixed evergreen zones are warm and dry while the higher zones such as red fir and mountain hemlock are cool and moist. Major tree species found within the major zones are listed on table 11.

Succession proceeds at varying rates depending on variation in soil, aspect and other factors. Plant succession is normally faster on more mesic sites and slower on warm dry sites, especially in the mixed conifer, mixed evergreen and white fir zones. Plants commonly controlled with herbicides in this sub-biome are shown in table 12.

TERRESTRIAL WILDLIFE

A wide variety of terrestrial animals is found in western Oregon since under pristine conditions, the basic requirements of food, water, cover and

Table 11 - Montane Sub-Biome Major Species Occurrence by Zone
S.W. Oregon Region

Species	Mixed C. or E.	White Fir	Red Fir
Western White Pine (*Pinus monticola*)	3	3	3
Sugar Pine (*Pinus lambertiana*)	2	3	3
Whitebark Pine (*Pinus albicaulis*)	4	4	3
Lodgepole Pine (*Pinus contorta*)	3	3	3
Ponderosa Pine (*Pinus ponderosa*)	2	3	4
Jeffrey Pine (*Pinus jeffreyi*)	3	3	4
Englemann Spruce (*Picea engelmannii*)	4	4	3
Western Hemlock (*Tsuga heterophylla*)	3	4	4
Mountain Hemlock (*Tsuga mertensiana*)	4	4	3
Douglas Fir (*Pseudotsuga menziesii*)	2	2	4
Grand Fir (*Abies grandis*)	3	4	4
Pacific Silver Fir (*Abies amabilis*)	4	3	2
White Fir (*Abies concolor*)	2	1	3
Noble Fir (*Abies procera*)	4	4	3
Shasta Red Fir (*Abies magnifica* var. *shastensis*)	4	3	1
Subalpine Fir (*Abies lasiocarpa*)	4	4	3
Incense Cedar (*Libocedrus decurrens*)	2	2	3
Western Redcedar (*Thuja plicata*)	3	3	4

1 = abundant, 2 = common, 3 = uncommon, 4 = rare or absent.

Table 12 - Montane Sub-Biome Important Competitor Plant Occurrence by Zone

Plant	Mixed Conifer	White Fir	Red Fir
Annual and perennial grass	2	2	3
Ceanothus sp.	1	3	1
Chinkapin	2	2	2
Manzanita sp.	2	3	2
Vine maple	2	2	2
Big leaf maple	2	3	4
Canyon live oak	1	3	4
Tanoak	1	3	4
Madrone	1	3	3
Blackberry	2	2	2

1 = abundant
2 = common
3 = uncommon
4 = rare or absent

space are usually well met for most species. Some animal species are represented in all sub-biomes. Others, more specific in their requirements, are found in only one or two.

Representatives of most terrestrial wildlife families are generally found in western Oregon. The number of indigenous mammals, birds, reptiles and amphibians commonly found inhabiting areas within the proposed action varies annually and seasonally. It is estimated that 200-300 species of wildlife could be involved on any one treatment area, excluding insects.

Population and Habitat Condition and Trend

General terrestrial wildlife habitat and population trends in western Oregon are illustrated on tables 13 and 14.

Sub-biomes - General Habitat Requirements

Wildlife typical of the forests are generally adapted to a closed canopy of coniferous timber interspersed with small openings. Some species, including the herbivores, such as deer and elk, respond to an edge effect created by forest meadows, logging, or fires that allow development of a nutritious non-coniferous vegetation. Other species, including the raptors and larger predators, utilize the forest openings as foraging area and the forest itself for seclusion. Accipiter hawks and the horned and northern spotted owls depend on tree-dwelling mammals for their prey, the redbacked

Table 13

Terrestrial Wildlife
Population and Habitat Trend 1/
(western Oregon)

	Estimated Population	Population	Habitat Quality	Habitat Quantity
Blacktailed Deer	74,500	I	S	I
Roosevelt Elk	4,703	S	D	S
Blackbear	1,126	S	D	S
Cougar	160	I	S	S

1/ Data source 1977, BLM Oregon Annual Wildlife Report

Table 14

Terrestrial Wildlife 1/
Acres and Condition of BLM Habitat
(western Oregon)

	Total Acres	Satisfactory	Unsatisfactory	Percent
Big Game	1,984,000	1,964,000	20,000	2
Small Game	2,384,000	2,164,000	220,000	10
Waterfowl	4,600	4,470	130	3

1/ Data source 1976 Oregon Annual Wildlife Report

Legend

I = Increasing
S = Stable
D = Decreasing

mouse, flying squirrels, and the small birds that are found in forested areas. Bald eagles and ospreys need dead and dying trees adjacent to lakes, streams, and the ocean for nest sites since their prey is principally fish.

Many fur-bearers and birds are adapted to a semi-aquatic habitat, and the presence of streams, lakes and ponds adds greatly to the diversity of wildlife. Permanent supplies of clean water should be available to wildlife at all times. In a so-called "virgin forest" this is usually not a limiting factor.

Wildlife species which most typically represent the three sub-biomes, found on Bureau lands in western Oregon, are illustrated in tables 14, 15, 16. It should be recognized that many of the species listed in the tables may in fact overlap one or all biomes, however, generally only the biome of highest occurrence or abundance is indicated.

A brief description of the sub-biomes and general wildlife habitat requirements follows:

Northwest Coastal Coniferous Forest. The Northwest Coastal Forest exists in areas where water is usually not a severe limiting factor to vegetative growth. Humidity is high and the temperature range is narrow. There is usually a deep layer of duff and organic soil rich in micro-organisms. The huge trees produce dense shade resulting in a poorly developed understory of vegetation preferred as a browse by big game species.

Table 15

Terrestrial Wildlife Most Representative of Western Oregon Biomes (Abundance)1/

Mammals	NW Coastal Coniferous Forest	Montane Coniferous Forest	Broad Sclerophyll
Pika		C	
Snowshoe hare	F	F	C
Brush rabbit	A		
Black tail jackrabbit	F		A
Mountain beaver	A	F	
Townsend chipmunk	F	C	
Yellow-bellied marmot		F	
California ground squirrel	F	C	A
Golden-mantled ground squirrel		C	
Western gray squirrel	F	C	A
Northern flying squirrel	C	A	
Pocket gopher	C	A	C
Beaver	C	C	F
Deer mouse	A	A	A
Bushytail woodrat	C		C
Dusky-footed woodrat	C	C	A
Red tree vole	A		
Porcupine	F	C	F
Gray fox			C
Coyote	C	C	C
Black bear	C	C	C
Raccoon	C		C
Ringtail cat			R
Spotted skunk			C
Mountain lion	R	R	
Bobcat	F	F	F
Roosevelt elk	C	C	
Black-tailed deer	A	A	A

1/ Abundance
- M - Migration
- A - Abundant (25+/day)
- C - Common (10-24/day)
- F - Few (1-9/day)
- R - Rate (5 or less/year)

Source: 1) Timber Management, A Programmatic Environmental Analysis Record for Western Oregon, (BLM)
2) Wm Nietro, Staff Wildlife Biologist BLM Oregon State Office

Table 16
Birds Found in Western Oregon

Birds	Oregon Status[1/]	Abundance N.W. Coastal Forest	Montane Forest	Broad Sclerophyll
Great Blue Herron	R	C		C
Woodduck	R	C	C	C
Common mergunser	R	U		C
Goshawk	R	R	U	
Red-tailed hawk	R	C	C	C
Golden eagle	R	U	U	U
Bald eagle	R	U	U	U
Osprey	SR	U	U	U
Sharp-shinned hawk	R	U	U	U
Blue grouse	R	C	C	
California quail	R	C		VC
Mountain quail	R	U	U	U
Band-tailed pigeon	SR	C	R	C
Great-horned owl	R	C	C	C
Screech owl	R	C	U	C
Spotted owl	R	U	U	
Rufous hummingbird	SR	C		C
Common flicker	R	C	C	C
Pileated woodpecker	R	U	U	
Blackbacked 3-toed woodpecker	R		U	
Lewis woodpecker	R			C
Acorn woodpecker	R	R	R	C
Gray jay	R	U	U	
Tree swallow	SR	VC	VC	VC
White-breasted nuthatch	R	C	C	U
Winter wren	R	C	U	
Robin	R	VC	C	U
Varied thrush	R	C	U	
Mountain bluebird	R			U
Townsend's solitaire	R	C		
Townsend's warbler	WV	U	U	U
Green-tailed towbee	SR		U	
Rufous-sided towbee	R	C	U	VC
Black-headed grosbeak	SR	C		
Dark-eyed junco	R	VC	VC	VC
White-crowned sparrow	R	VC		C
Fox sparrow	R	C	C	U
Song sparrow	R	VC	C	C

1/ Data adapted from Betrand and Scott, 1971 (with modification by author, Wm. Neitro)

Abundance
VC - Very common; 50 or more birds per day
C - Common; 10-49 birds per day
U - Uncommon; 0-9 birds per day
R - Rare; 5 or less birds per year

Status
R - Resident
WV - Winter Visitor
SV - Summer visitor; nonbreeder
SR - Summer resident; breeds in state

Source: See table 14

Table 17

Reptiles and Amphibians Found in Western Oregon

	NW Coastal Coniferous Forest	Montane Coniferous Forest	Broad Sclerophyll
Reptiles			
Pacific rattlesnake			X
Sharp-tailed snake			X
California mountain kingsnake		X	
Pudget Sound garter snake	X		
Pacific rubber boa	X		
Amphibian			
Pacific tree frog		X	
Siskiyou mountain salamander			X
Pacific giant salamander	X		

X = commonly found in this biome

Source: See table 14

Some wildlife are found in more specific zonal types: the hemlock looper (Ellopia fascellaria lugubrosa) and the Sitka spruce beetle (Dendroctonus obesus) are defoliators of commercial conifers.

In the Northwest Coastal Coniferous Biome, the Trowbridge's shrew (Sorex trowbridgii t.), an insectivore, feeds on Douglas fir seed.

The fisher (Martes pennanti) and the rare flammulated owl, (Otus flammeolus) are found in the forested areas below timberline.

The wolverine, also considered endangered by the State, is found in alpine habitat.

The endangered Oregon white-tailed deer is found on the Roseburg district and along the bottomlands of the lower Columbia River.

The Northwest Coastal Coniferous Biome produces desirable wildlife food sources following fires, logging, and other disturbances to the overstory more rapidly than Montane forests due to better soils, moisture conditions and lower elevations. Water is not usually a limiting factor.

Deer and elk generally follow any natural or man-made opening in the dense overstory, such as caused by fire or logging, to take advantage of resulting nutritious ground vegetation. Adjacent closed canopy forests that provide winter cover and escape shelter are a crucial part of game animal habitat.

The cougar and black bear inhabiting this sub-biome are species that need the seclusion and escape cover afforded by dense forests or areas which are generally inaccessible to man.

Many of the small mammals, birds, and amphibians found in coastal forests depend on the variety of insect life that abounds in the damp, mild environment, as well as the great mass of seeds produced by evergreen trees and various shrubs.

Mink, marten, otter, beaver, and muskrat favor this habitat due to the proximity of lakes and streams that afford food, bank dens, and travel routes. While waterfowl are not normally considered as representative birds of timbered habitat, many ducks use the lakes, rivers, and estuaries adjacent to the moisture-holding forest lands. Some ducks, including the golden-eye, bufflehead, and wood duck, nest in tree cavities adjacent to water.

In addition to the terrestrial wildlife listed for the Northwest Coastal Coniferous Biome many forms of aquatic and semi-aquatic wildlife (birds and mammals) inhabit the sub-biome. They include the beaver, muskrat, raccoon, mink, otter, dipper, great blue heron, and belted kingfisher.

Many other species of shorebirds and waterfowl seasonally use the water ways, heliponds and small lakes for resting areas during migration periods.

The northern bald eagle and osprey are also often found along the major and tributary streams and rivers. Seasonally these species are found associated with fresh water habitat in this biome, which is relatively free from man's influence.

Montane Coniferous Forest Biome. A greater variety of habitat exists in this sub-biome than in the coastal forest, due to the variety of vegetative types. This allows a high degree of use by adaptable wildlife.

As with the coastal forest sub-biome, many other wildlife species are found by regions of the Montane Forest such as the black salamander.

In the Cascades, the Roosevelt elk and Rocky Mountain elk have intermingled until it is difficult to differentiate between the two sub-species. Parts of this zone may have mule deer concentrations as well as blacktailed deer populations. The Northern flying squirrel is common in the mixed forests of this area as is the northern Pacific rattlesnake. Destructive beetles, such as the bark beetle, infest commercially valuable ponderosa pine.

Water can be a limiting factor in portions of this sub-biome. The diversity of habitat and climatic conditions produces a diversity of wildlife. Woodpeckers make extensive use of the oaks and other hardwoods found in parts of this sub-biome for food, food storage and nesting. Many other birds and small animals also use cavities in dead and dying trees as nest and den sites. The many herbivores inhabiting this sub-biome utilize most of the

upper areas as summer range. Deep snows and cold preclude year-round residency for some species such as deer and elk. These ruminants must have suitable winter range within reasonable migration distance for survival.

As noted for other timbered areas, the larger predators--wolverine, bear, and cougar must have areas generally inaccessible to man for survival.

Broad Sclerophyll. A portion of the Montane Coniferous Forest merges with hardwood trees and brush in southwestern Oregon. The Broad Sclerophyll sub-biome adjacent to the Siskiyou, Klamath, and Cascade Mountains contains many important wildlife species more closely related to California forms than to the Rocky Mountain species.

The Broad Sclerophyll is an extension of the transition zone of central Oregon, and some of the wildlife found along the fringes of the Rogue River valley are similar to central Oregon brushland species. For example, the magpie, golden eagle, California ground squirrel, and black tailed jack rabbit are present.

Wildlife are dependent on the great variety of transition zone hardwood trees and shrubs. Acorns provide food for tree and ground squirrels, certain woodpeckers, and wood ducks and are readily used by blacktailed deer in the fall and winter. Ceanothus, manzanita, scrub oak, and mountain mahogany are preferred browse species for wintering deer. The Pokegama - Jenny Creek area on the California border provides winter range for the largest migrating

blacktailed deer herd in Oregon. Some mule deer are also found on the winter range.

This sub-biome can become very hot and a shortage of water can be a major limiting factor. Many small streams and ponds go dry during the summer. Brush invasion after fires or logging occurs as a natural process of plant succession. In this sub-biome these brushfields are prominent and succession to the climax stage generally takes many years due partially to soil and climatic conditions. After an initial growth period the brushfields become dense and decadent and thus wildlife forage quality declines. The brushfields do provide excellent cover for large animals and nesting sites for birds.

General Food Habits of Terrestrial Wildlife

Table 18 illustrates the primary food items (Martin, et al., 1951) of the animals of major importance which are expected to be found in all biomes related to the proposed action. However, it must be recognized that the food items and habits of most wildlife species change seasonally with availability.

Invertebrates

Invertebrates are the most numerous animals found in the forest sub-biomes concerned by the proposed action. The invertebrates far outnumber vertebrate animals in both terrestrial and aquatic environments.

Table 18
Terrestrial Wildlife Primary Food Habitats and Items

Birds	Food Habitat	Food Item
Nighthawk	entirely insectivorous	flying ants, mosquitoes, beetles, moths
Poor-will	" "	grasshoppers, beetles
Hummingbird	nector and insects	plant nector
Common Goldfinch	primarily seed eater	thistle
Winter wren	insectivorous - at least seasonally	insects
Brown creeper	" "	caterpillars, spiders, beetles
Nut hatches	" "	beetles, moths, ants
Dipper	insectivorous	aquatic insects
Mountain bluebird	herbivorous	elderberry, wild grape
Rufous sided towhee	"	oak, raspberry
Oregon junco	"	chickweed
Western tanager	"	cherry
Varied thrush	"	oak, madrone, snowberry
Flicker	"	elderberry, insects
Bandtail pigeon	"	oak, madrone
Mountain quail	"	lupine
Valley quail	"	filaree
Blue grouse	"	blueberry
Yellow warbler	insectivorous	flies, beetles, ants
Nashville warbler	"	flies, beetles, ants
Mammals		
Bats	entirely insectivorous	flies, moths
Shrews	primarily insectivorous	various insects
Moles	" "	earthworms
Animals		
Meadow mice	herbivorous	grasses, clover
Opposum	omnivorous	acorns, insects, frogs
Black bear	"	various fruits, oaks, shink cabbage
Yellow-bellied marmot	herbivorous	grasses
Douglas chickaree	"	salal, hazelnut
Western gray squirrel	"	oak, tree seeds
Pika	"	fireweed
Blacktailed jackrabbit	"	filaree, clovers
Blacktailed deer	"	blackberry, oaks, vine, maple, thimbleberry
Roosevelt elk	"	trailing blackberry
Amphibians		
Frogs and toads	partially insectivorous	flies
Reptiles		
Lizards	"	grubs, ants

1/ Martin, Zim, Nelson (1951)

Invertebrates, especially insects, have great significance as food chain items of vertebrates. Little data is available on the populations of insects in western Oregon. Table 18 illustrates some of the important orders of insects expected to occur in western Oregon forest biomes.

For this discussion insects have been grouped in two categories; subterranean and terrestrial or above ground species. The subterranean species may live at least part of their life cycle underground; examples include earthworms and grasshoppers. Terrestrial or above ground insects live on the ground, under rotting logs, in shrubs, and in the forest canopy. Examples of these include spiders, ants, wasps, flies, beetles and others.

Forest Successional Stages

A short discussion on forest successional stages is included here to outline the importance of the various seral stages in relation to the diversity of wildlife species.

Franklin and Dyrness (1973) have described the various successional stages of Douglas fir in western Oregon. Generally, the stages advance from a grass-forb, to shrub-sapling, to second growth, and then mature forest. Meslow and Wight, 1975, and Thomas, et al, 1975, 1977, generally agree that the grass-forb, shrub-sapling stage extends up to 10-15 years in a typical forest. Thomas, et al, 1975 also have illustrated the birds species typical of various successional stages of the western coniferous forest biomes (table

Table 19

Important Orders of Insects Expected
to Occur in Western Oregon Forest Biomes

Order	Representative
Odonata	Dragonflies
Orthaptera	Grasshoppers
Hemiptera	Backswimmers
Homaptera	Aphids
Neuroptera	Dobsonflies
Coleaptera	Metallic Wood Boring Beetles
Lepidoptera	Horse and deer flies
Siphonaptera	Common fleas
Hymenaptera	Bees

20). Meslow and Wight (1975) have illustrated that species diversity increases with increasing vegetative complexity. The importance of the grass-forb and shrub-sapling of the Douglas fir forest to birds is depicted on table 21. The authors have concluded that of the 84 breeding bird species determined to be found in the Douglas fir forest, 86 percent of the species use the shrub-sapling stage and 39 percent nest in that stage. Thirteen species were found to nest primarily in the shrub-sapling stage.

Thomas, et al, 1977 report that in the Blue Mountains the following listed mammals major life functions (feeding and reproduction) occurred primarily in the grass-forb and shrub-sapling stage. The mammals include Pika, Yellow-bellied marmot, Pinon mouse, Black-tailed jackrabbit, and Least chipmunk. Many of these animals also occur in western Oregon. Lindzey and Meslow, 1977 have described the dependence of black bears on the early seral stages, especially clearcuts in western Oregon and Washington, due to increased food availability brought about by timber harvest.

Endangered, Threatened and Sensitive Wildlife

Table 22 lists the endangered, threatened, sensitive or those species pending final rulemaking by the U. S. Fish and Wildlife Service. Classification and agency designation is contained in the table.

Birds listed as sensitive species are those included on the Audubon Society's Blue List for 1977. The only exception is the golden eagle which receives protection under the Bald Eagle Act.

Table 20

Bird Species Typical of Successional Stages
by Life Zones in Western Coniferous Forests

<u>Spruce-hemlock zone</u> (Sub-biome 1)	
Old growth	Boreal owl* (Aegolius funereusu)
Mature forest	White-winged crossbill* (Loxia leucoptera)
Young forest	Black-backed three-toed woodpecker (Picoides arcticus)
Shrubs	Varied thrush (Ixoreus naevius)
Grass-forb	Golden-crowned sparrow (Zonotrichia atricapilla)
<u>Fir zone</u> (Sub-biome 1 and 2)	
Old growth	Spotted owl (Strix occidentalis)
Mature forest	Pine grosbeak (Pinicola enucleator)
Young forest	Williamson's sapsucker (Sphyrapicus thyroideus)
Shrub	Swainson's thrush (Hylocichla ustulata)
Grass-forb	Oregon junco (Junco oreganus)
<u>Pine zone</u> (Sub-biomes 2 and 3)	
Old growth	Pileated woodpecker (Dryocopus pileatus)
Mature forest	Red crossbill (Loxia curvirostra)
Young forest	White-headed woodpecker (Dendrocopos albolarvatus)
Shrub	Townsend's solitaire (Myadestes townsendi)
Grass-forb	Green-tailed towhee (Chlorura chlorura)

*Rare occurrence in Oregon.

Table 21

Importance and Use of Two Seral Stages of Vegetation Common in the Three Western Oregon Sub-biomes

	Grass-Forb	Shrub-Sapling
Savannah sparrow	XXX	X
Vesper sparrow	XXX	X
White-crowned sparrow	XX	XX
Song sparrow	XX	XX
Nighthawk	XX	XX
Dark-eyed junco	XX	XX
Fox sparrow	X	XXX
Chipping sparrow	X	XXX
Rufous-sided towhee	X	XXX
American gold finch	X	XXX
Blackheaded grosbeak	-	XX
Bewiek's wren	X	XXX
Yellow warbler	-	XXX
Nashville warbler	-	XXX
Orange-crowned warbler	-	XX
Warbling vireo	-	XX
Solitary vireo	-	XX
Mac Gillervray's warbler	-	XX
Yellow-rumped warbler	-	XX
Black-throated gray warbler	-	XX
Hutton's vireo	-	XX
Swainson's thrush	X	XX
Varied thrush	X	XX
Robin	X	XXX
Common bushtit	X	XXX
Scrub Jay	X	XX
Steers Jay	X	XX
Western wood pewel	X	XX
Western flycatcher	-	XX
Traill's hummingbird	-	XX
Callrape hummingbird	-	XXX
Mourning dove	-	XX
Mountain quail	X	XX
Tree swallow	X	XX
Purple martin	X	XX
Western bluebird	X	XX
Mountain bluebird	X	XX

1/ Adapted from Meslow and Wight (1975)

X - uses that seral stage, but not for nesting
XX - nests in seral stage
XXX - nests primarily in seral stage

Table 22

Wildlife Classified as Endangered, Threatened, Sensitive, or Pending Final Rule Making (Western Oregon BLM Lands)

	1/ Classification	2/ List	3/ Est. Pop.	4/ Pop.	Habitat Quality	Habitat Quantity
Peregrine Falcon	E	F&S	5/	-	-	-
Northern Bald Eagle	T	(F-P) +S	7/	S	D	D
Northern Spotted Owl	T	S	200	D	D	D
Wolverine	T	S	-	-	-	-
Columbian White-tailed Deer	E	F&S	-	-	-	-
Western Spotted Frog	T	T	-	-	-	-
Red-necked Grebe	S	6/	8/	D	-	-
Western Grebe	S	6/		S		
Sharp-shinned Hawk	S			I		
Golden Eagle	S	6/	8/	D		
Osprey	S	6/		I		
Prairie Falcon	S	6/		S		
Merlin	S	6/		D		
American Kestrel	S	6/		I		
Common Nighthawk	S	6/		D		
Lewis Woodpecker	S	6/		I		
Mountain Bluebird	S	6/		D		
Yellow warbler	S	6/		D		
Yellow-breasted Chat		6/		D		

1/ E = Endangered; T = Threatened; S = Sensitive
2/ F = Federal; S = State; P = Pending list
3/ Present known population BLM lands
4/ Data source 1977 BLM Annual Wildlife Report
5/ Unknown
6/ Audubon's Blue List 1977
7/ Protected by the Bald Eagle Act
8/ Audubon Blue List - Species in no apparent trouble in North Pacific Coast Region

Legend

I = Increasing
S = Stable
D = Decreasing

It should be noted here that all birds except the starling and house sparrow receive protection under the Migratory Bird Treaty Act.

Table 22 includes only those species found in western Oregon either as residents, migrants; or those species which may utilize proposed herbicide project areas for some life functions, such as nesting or feeding.

SOILS

The system of soil classification in the U.S. is similar to the systems used to classify plants and animals. Soil classification utilizes the soils' physical, chemical and mineralogical properties as well as factors which influence plant growth. Climate, soil depth, coarse fragment content and soil drainage are a few of the items which influence plant growth and are used to separate one kind of soil from another.

There is a tremendous variation in kinds of soils occurring in western Oregon. This variation decreases as one ascends the categorical rungs of the classification scheme. Each sub-biome contains a group of soils, at some higher level of classification, which are similar in many characteristics. This is because climate and vegetation are reflected in soil development just as climate and soils are major items in the evolution of a plant community.

On the above premise some of the major soil series will be described for each sub-biome. It must also be remembered that the soils in each sub-biome

are quite variable when considered at the lower classification categories (the more detailed separations). There are transitional types of soils which occur in more than one sub-biome. The major soils discussed for each biome occur extensively and are examples of numerous soil series with similar characteristics.

General definitions of terms used in the following sections are as follows:

Clayey - Soils containing over 35 percent clay in the fine-earth fraction.

Clayey-skeletal - Soils containing over 35 percent coarse fragments by volume and more than 35 percent clay in the fine-earth fraction.

Loamy-skeletal - Soils containing greater than 35 percent coarse fragments by volume and the fine-earth fraction contains less than 35 percent clay.

Fine-silty - Soils containing less than 15 percent by weight, particles greater than 0.1 mm in size and contains 18 to 35 percent clay in the fine-earth fraction.

Fine-loamy - A soil containing 15 percent or more particles which are greater than 0.1 mm in size and contain 18 to 35 percent clay in the fine-earth fraction.

Coarse-loamy - A soil containing 15 percent or more particles which are greater than 0.1 mm in size and contains less than 18 percent clay in the fine-earth fraction.

Cindery - A soil containing 60 percent or more (by weight) volcanic ash, cinders, and pumice; 35 percent or more (by volume) is cinders that have diameters of 2 mm or more.

Ashy - The same as cindery except there are less than 35 percent of 2 mm size diameter or larger.

Temperature

Mesic soils have mean annual temperatures of 47 degrees F. or more. Cryic soils have mean annual temperatures less than 47 degrees F.

Moisture

Xeric soils are dry for 45 or more consecutive days, 6 out of 10 years. Udic soils are not dry for 90 cumulative days, nor 45 consecutive days. Mesic soils are saturated by ground water for some period of time each year.

Some soil properties, qualities and interpretations for selected soils are presented in tables 22, 23, and 24 for each respective sub-biome briefly discussed in the following paragraphs. Detailed soil reports though must be

Table 23 - Soil Physical Properties, Qualities, Hazard Ratings and Relative Productivity for Selected Soils in Sub-biome 1 (Northwest Coastal Forest)

Soil[1/] Series (Order)	Key to Geographical Distribution (see Fig.)	Soil Depth (in)	Thickness of "A" Horizon (in)	Texture of[2/] "A" Horizon	Permeability[3/] in/hr	Reaction (pH)	Erosion Hazard[4/] Percent Slope -35	35-60	60+	Compaction[5/] Hazard	Timber Productivity (Site Class)
Salkum (Ultisol)	A	60+	14	silty clay loam	.06-.20	4.5-6.0	low	-	-	medium	III
Willamette (Mollisol)	A	20-40	4	silty clay loam	.20-.60	5.6-6.0	low	med	high	medium	III
Jory (Ultisol)	G	60+	12	silty clay loam	0.2-0.6	4.5-6.0	low	med	high	high	III
Willakenzie (Alfisol)	G	20-40	6	silty clay loam	0.2-0.6	5.6-6.0	low	med	high	high	III
Witzel (Mollisol)	G	12-20	4	cobbly silty loam	0.2-0.6	5.6-6.0	low	med	high	low	IV
Honeygrove (Ultisol)	H	60+	12	silty clay	0.16-2.0	6.1-6.5	low	med	high	high	II
Astoria (Inceptisol)	H	60+	19	silt loam	0.6-2.0	4.5-5.0	med	high	high	medium	II
Digger (Inceptisol)	H	20-40	4	gravelly loam	2.0-6.0	5.6-6.0	low	med	high	medium	III
Umpcoos (Inceptisol)	H	12-20	3	gravelly loam	20.0+	5.6-6.0	low	med	high	low	IV
McGinnis (Ultisol)	H	20-40	6	gravelly loam	0.2-0.6	5.8-6.2	med	high	high	medium	III & IV
Beekman (Inceptisol)	H	20-40	4	very gravelly loam	2.0-6.0	6.1-6.6	low	med	high	low	IV
Orford (Ultisol)	C	40	14	silty clay loam	0.2-0.6	5.1-5.5	low	med	high	high	II & III

1/ Series names identified by asterisk are not officially established
2/ USDA textural class
3/ Based on least permeable soil layer
4/ Based on bare soil conditions
5/ Based on reduction of pore space which impedes root development and air and water movement.

Table 24 - Soil Physical Properties, Qualities, Hazard Ratings and Relative Productivity for Selected Soils in Sub-biome 2 (Montane Coniferous Forest)

Soil Series (Order)	Key to Geographical Distribution (see Fig)	Soil Depth (in)	Thickness of "A" Horizon (in)	Texture of 1/ "A" Horizon	Permeability 2/ in/hr	Reaction (pH)	Erosion Hazard 3/	Compaction 4/ Hazard	Timber Productivity (Site Class)
Tapine (Entisol)	J	60+	4	gravelly-loamy coarse-sand	20.0+	5.6-6.5	low	low-med	SI=90 (p.pine) SI=80 (D.Fir)
*Pok[illegible] (Mollisol)	K	40+	8	loam	0.2-0.6	6.1-6.5	low	low	SI=82 (p.pine)
Wamic (Entisol)	L	40+	7	loam	0.2-0.6	6.6-7.3	high	low	SI=50-70 (p.pine)
Wickiup (Entisol)	J	60+	2	loamy-sand	6.0-20.0+	5.6-7.3	low	low	SI=80 (Lodgepole pine)
*Shanahan (Entisol)	J	40+	4	coarse sandy loam	.12-.26	6.1-7.3	low	low	SI=80 (p.pine)
*Woodcock (Mollisol)	K	40+	10	very gravelly loam	0.6-2.0	6.1-7.3	med	med	SI=80 (D.Fir)

1/ USDA textural class
2/ Based on least permeable soil layer
3/ Based on bare soil conditions
4/ Based on reduction of pore space which impedes root development and air and water movement

Table 25 - Soil Physical Properties, Qualities, Hazard Ratings and Relative Productivity for Selected Soils in Sub-biome 3 (Broad Sclerophyll)

Soil Series (Order)	Key to Geographical Distribution (see Fig)	Soil Depth (in)	Thickness of "A" Horizon (in)	Texture of[1/] "A" Horizon	Permeability[2/] in/hr	Reaction (pH)	Erosion Hazard[3/]	Compaction[4/] Hazard	Timber Productivity (Site Class)
*Carney (Vertisol)	A	20-40	11	clay	-.06	6.1-7.3	med-high	high	----
Freezener (Alfisol)	C	50+	9	loam	0.2-0.6	5.4-6.0	high	med	III
Josephine (Ultisol)	G, C	40-60	3	gravelly loam	0.2-0.6	5.6-6.0	high	high	III
Medford (Mollisol)	A	40-60	12	silty clay loam	0.2-0.6	6.1-7.3	low	med	6-7 tons hay/A
*Pearsall (Inceptisol)	C	10-20	5	very gravelly clay loam	.06-0.2	6.1-7.3	high	high	----
Siskiyou (Inceptisol)	C	20-40	4	gravelly sandy loam	2.0-6.0	5.1-6.0	high	low	SI-110 (a.pine)

1/ USDA textural class
2/ Based on least permeable soil layer
3/ Based on bare soil conditions
4/ Based on reduction of pore space which impedes root development and air and water movement

referred to for specific ratings under various conditions for these soils and for other soils not listed in the tables. In addition each table keys the soils geographical distribution to a map (figure 4).

Northwest Coastal Coniferous Forest (Sub-biome)

The Salkum series is a dark brown, clayey soil occuring in the xeric-mesic zone on terraces along margins of the Willamette Valley. Willamette soils are reddish, fine-silty soils occurring on foothills along the Willamette Valley.

Jory soils are red and clayey and occur in the xeric-mesic zone at lower elevations adjacent to the interior valleys. Willakenzie soils are red, fine-silty soils also in the xeric-mesic zone, as the jory soils but, occur at lower elevations. Witzel soils are dark brown, xeric, loamy-skeletal soils also on low foothills along the margins of the interior valleys.

Honeygrove soils are similar to the jory soils except they occur at intermediate elevations in the udic-mesic zone. Both soils are located in the Cascade and Coast Range Mountains. Astoria soils are brown, fine, soils occurring in the udic-mesic zone. These soils are dominantly located on the west side of the Coast Range Mountains and areas in the north which drain into the Columbia River.

WESTERN OREGON - GENERAL SOIL MAP

Figure 4

Characteristics of soil orders in western Oregon

The soil orders found in western Oregon. Mollisols have dark surfaces formed under grass; Alfisols are produced, under forests, by downward leaching of clay; Ultisols are similar but their bases have been more completely depleted; Spodosols reflect translocation of iron or aluminum and organic matter under forest; Inceptisols represent early stages of soil formation; Vertisols are dominated by swelling clays; Histosols are formed in organic deposits; and Entisols lack genetic horizons. The map illustrates 8 kinds of soil landscape, combining soil orders that occur in similar climates and terrain.

WARM SOILS OF MODERATE RAINFALL
WESTERN OREGON REGIONS

Mollisols, Alfisols, Vertisols and Ultisols of Valleys — A

Soils of the Willamette Valley floodplain and terrace are dominantly deep, silty, moderately dark and somewhat acid. Poorly-drained soils are common. Soils of the southwestern valleys are generally less silty, more variable in depth and lighter-colored, although dark clay Vertisols are common. Reddish, strongly-leached Ultisols occur on older terraces and footslopes.

Alfisols, Ultisols, Inceptisols, Mollisols and Vertisols of Foothills and Mountains — G

These uplands have a pronounced summer dry period. The soils are highly variable, but mostly dark at the surface, clayey and moderately acid in the north, becoming lighter-colored, less acid and less clayey in the south.

WARM SOILS OF HIGH RAINFALL
WESTERN OREGON REGIONS

Spodosols, Inceptisols and Entisols of Valleys and Coastal Lowlands — B

These soils are strongly acid, mainly dark and deep. Poorly drained, clayey soils are common in the stream valleys and estuaries. Gravelly soils predominate in western Cascade valleys. Sandy spodosols, commonly with iron-cemented subsoils, occur on lower coastal terraces. Entisols on younger dunes.

Inceptisols, Alfisols and Ultisols of the Western Klamath Mountains — H

These areas are steep and heavily forested. The soils are mostly dark, loamy or clayey. Shallow, stony soils are common with deeper, reddish, clayey Ultisols on smoother slopes.

Inceptisols and Alfisols of the Klamath Mountains — C

These soils are dominantly light-colored, medium to slightly acid, loamy, and commonly stony and shallow. Granitic areas have sandy soils and serpentine areas have mostly shallow, reddish, clayey soils.

Inceptisols, Spodosols and Entisols of High Mountains — I

Soils of the forested higher elevations are mostly dark, moderately to strongly acid, shallow and stony. Light-colored, coarse-textured Entisols and Spodosols occur on glacial deposits.

WARM SOILS OF MODERATE RAINFALL
EASTERN OREGON PORTRYN REGIONS

Ultisols and Spodosols of the Central Oregon Pumice Plateau — J

Soils formed on coarse pumice are mostly light-colored, coarse-textured, and moderately to slightly acid. Strongly acid Spodosols with subsoils of iron accumulation have formed at higher elevations. Poorly-drained soils occur in depressions.

Mollisols and Inceptisols of the Mountains — K

Soils of the mountainous lava plateaus are mostly dark, moderately to slightly acid, loamy, moderately deep or shallow and stony. Taffiness textures areas have clayey soils. Light-colored, silty Inceptisols from volcanic ash occur on broad plateaus and northerly slopes.

Source: G.H. Simonson, Soil Science Department, OSU, in cooperation with Soil Conservation Service, U.S.D.A., August 1975

Digger and Umpcoos soils are brown, loamy-skeletal and are located on sedimentary bedrock in the Coast Range Mountains. Umpcoos soils are less than 20 inches to hard bedrock. Both of these soils occur in the udic-mesic zone.

The Bureau of Land Management has mapped extensive acreages of McGinnis and Beekman soils in the xeric-mesic zone of the Klamath Mountains. The McGinnis soils are red, clayey-skeletal while the Beekman soils are brown and loamy-skeletal. Orford soils are located on the southern Oregon coastal areas. These soils are brown, clayey and occur in the udic-mesic zone.

Montane Coniferous Forest (Sub-biome)

Lapine soils are dry, cold, excessively drained, gray brown, gravelly loamy coarse sands. They have formed in pumice mantled lava plains. Pokegema soils are dry, cold, well drained, reddish-brown, clay loams. They are formed in mudflows having weathered andesitic rock fragments. Wamic sofls are dry, warm, well drained, gray brown, ashy loams. They are formed in volcanic ash and loess over medium textured alluvium or colluvium weathered from basalt or andesite on forested plateaus. Wickup soils are wet, cold, somewhat poorly drained, dark gray, cindery soils. They are formed in cinders and ash along drainage ways and depressions on pumice mantled lava plateaus. Shanahan soils are dry, cold, deep, somewhat excessively drained, gray brown, ashy soils. They are formed in volcanic ashy mantles over buried loamy soils. Woodcock soils are dry, cold, well drained, very dark brown, stony

loam soils formed in colluvium on glacial outwash plains, mountainous escarpments and mudflows weathered mainly from andesite, basalt and some volcanic ash and cinders.

Broad Sclerophyll (Sub-biome)

Carney soils are dry, warm, well drained, dark brown, clay and occur on footslopes. Freezener soils are dry, warm, deep, well drained, reddish brown, clays. They are formed over basalt and occur in the steep uplands. Josephine soils are dry, warm, moderately deep, well drained, reddish brown clay loams. They are formed over metamorphosed sandstone and shale and occur in the uplands. These soils are unique as they contain sufficient magnesium to inhibit many plant species. Medford soils are xeric, mesic, deep well drained, black silt loams. They are formed in alluvium and occur on terraces and valley bottoms. Pearsoll soils are xeric, mesic shallow, well drained, clayey-skeletal soils. They are formed in cobbly fine textured colluvium weathered from fractured serpentinite or peridotite and occur on mountainous slopes. Siskiyou soils are xeric, mesic, moderately deep, excessively drained, yellowish brown, coarse-loamy soils. They are formed on granitic rocks and occur in the foothills and upland.

Soil Organisms

The soil environment in the three sub-biomes found in western Oregon is one of intense microbiological activity. Vast numbers of soil flora and fauna

exist on or below the forest floor but, are most abundant in upper soil layers which are enriched almost continuously by plant wastes. Most are so minute as to be seen only by the aid of the microscope but, they play vital roles in many physiological processes which are essential to the existence of higher plant forms and larger animals. These organisms are also vital in the process of forming soil plant and animal residues.

Microscopic forms such as bacteria, fungi, certain molds, and algae predominate and from certain standpoints, are more important than the larger animal forms. They are extremely important in decomposing organic residues, increased efficiency of nutrient uptake by higher plants, increase the availability of nutrients through oxidation, evolution of carbon dioxide, and symbiotic association with the roots of trees and lesser vegetation.

Moisture, aeration, temperature, reaction (pH), and organic matter are the most important factors that enhance microbial activity (division, metabolism) in the soil which favors decomposition of organic residues (e.g. phenoxy herbicides) into cell substance and to carbon dioxide and water by heterotrophic bacteria. Some optimum conditions would be 50 to 100 percent of a soils field capacity, good aeration, 80 to 90 degrees F, and pH range of 6.5 to 8.

These organisms commonly occur through each sub-biome but are not distributed uniformly within soils or geographic regions. Also they are not as abundant in soils which are cold, poorly drained or low in organic matter

and in strongly acid or highly alkaline soils. The wickiup soils for example, found in the montane coniferous forest sub-biome, are somewhat poorly drained, have a high water content between October and April, little organic mattter, and low soil temperatures; conditions that are not favorable for high populations of soil organisms.

The activity of animal forms such as rodents, insects and earthworms result in the pulverization, granulation, and transfer of considerable quantities of soil and initiate decomposition processes to be continued further by bacteria and fungi. They incorporate organic matter into soils, improving soil structure, aeration, drainage and water holding capacities.

AQUATIC ORGANISMS

Aquatic and Riparian Vegetation

Vegetation is a vital component of aquatic ecosystems because plants are the beginning of the food chain--only they can fix biochemical energy and synthesize basic organic substances. Aquatic plants therefore provide food and cover for insects, other invertebrates, fish, waterfowl, fur bearers, big game, and non-game birds and animals. Growth of aquatic vegetation along streambanks and lakeshores prevents soil erosion and contributes to the natural beauty of the ecosystem.

Riparian and aquatic plants are a vital component of all aquatic ecosystems; and since they are relatively common to all three sub-biomes, they will be described on the basis of those found in the Coniferous Forest Biome.

Some aquatic plants grow in nearly all waters of the State depending on suitable temperature, water depth and movement, available nutrients, salinity, light for photosynthesis, and sufficient time for growth and reproduction. These plants are often found in an aquatic environment and classified as either running (lotic) or standing (lentic) water habitat.

The running water habitat includes the smallest mountain streams at high altitudes (5500 feet above sea level) to major rivers at low elevations (sea level). Water originating in all watersheds in western Oregon eventually enter the Pacific Ocean. Streams at higher elevations generally contain less vegetation than those at lower elevations due to steeper gradients, cooler water, and a lower concentration of nutrients. Streams are classified according to their importance. Two stream classes are recognized by the State of Oregon. A Class I stream is defined as waters which are valuable for domestic use, are important for angling or other recreation and/or used by significant numbers of fish for spawning, rearing or migration routes. Stream flows may be either perennial or intermittent during parts of the year (Oregon Forest Practices Act, 1975). There are 1,752 miles of Class I stream that run through BLM lands in western Oregon (table 26).

TABLE 26

Class I Streams (Miles)
BLM -- Western Oregon

District	Total	Miles of stream within or adjacent to proposed project areas (aerial)
Salem	305	9.8
Eugene	300	12.6
Roseburg	157	12.0
Medford	404	12.0
Coos Bay	286	24.0
Total	1,752 miles	70.4 miles

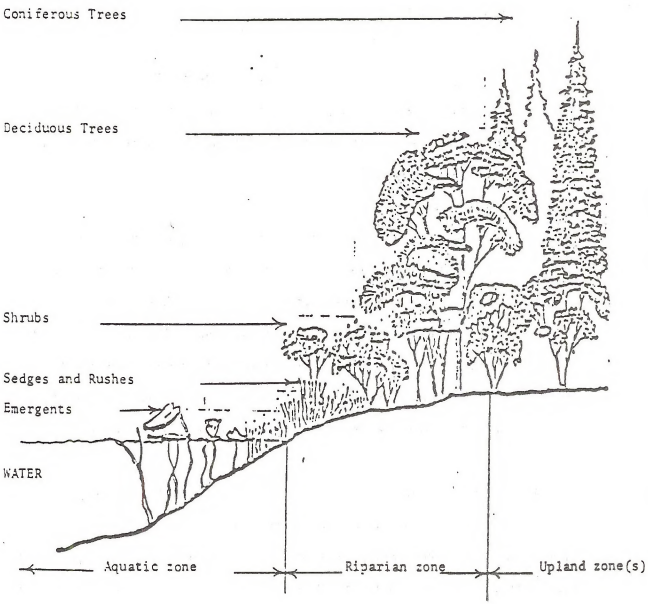
Lakes, reservoirs, ponds, marshes and bogs make up the standing water habitat of western Oregon. A greater variety and more abundant growths of vegetation usually occur in standing rather than in running water environments. Natural lakes can be classified into three groups according to their morphometry and productivity--young, maturing or old. A total of 3,900 surface acres of reservoirs and 364 acres of lakes are on BLM lands in western Oregon.

Most young lakes are found at higher elevations in the Coniferous Forest Biome, whereas maturing lakes occur in all biomes at all elevations. Mature lakes, ponds and marshes (both marine and freshwater, including estuaries) are areas of enormous biological productivity because of the rich waters and abundant communities of aquatic vegetation and adjacent riparian vegetation (figure 5).

Aquatic plants are usually grouped into three general categories--floating, submersed and emersed. Representative plant species widespread in Oregon and probably common to all sub-biomes are listed by genera as follows:

RIPARIAN ZONE
(Illustration)

Figure 5



The riparian zone is identified by the presence of vegetation that requires large amounts of free or unbound water.

- Floating. Green and blue-green algae; duckweed (Lemna and Spirodela); water shield (Brasenia); pond lily (Nuphar); and floating pondweed (Potamogeton).

- Submersed. Stonewort (Chara); bladderwort (Utricularia); some pondweed (Potamogeton); Hornwort (Certatophyllum); water milfoil (Myriophyllum); water buttercup (Ranunclus); mare's tail (Hippuris); and elodea (Elodea).

- Emersed. Cat-tail (Typha); bulrush (Scirpus); yellow cress (Rorippa); buttercup (Ranunculus); bur-reed (Sparganium); water persicaria (Polygonum); water plantain (Alisma); arrowhead (Saggitaria); sedge (Carex); spikerush (Eleocharis); horsetail (Equisetum); cyperus (Cyperus); rush (juncus); mannagrass (Glyceria); common reed (Phragmites); slough grass (Beckmannia); reed canarygrass (Phalaris); willow (Salix); alder (Alnus) and cottonwood (Populus).

Aquatic plants tend to grow in communities according to water depth, which is probably the major habitat requirement for most species. In aquatic ecosystems some plants occur in open water, others occupy the littoral zone, and different species grow along the shores of lakes and banks of rivers (riparian vegetation).

Plant communities in standing water environments are constantly changing due to natural processes. Shoal areas, for example, are developed by sedimentation from shore erosion and tributary streams. Rooted vegetation grows on

the shoals and contributes to filling of lakes by retaining debris and sediment. Tributary streams continue to add more nutrients. Dense growth of emergent plants extend outward from shore.

Riparian zones are those areas associated with surface water that reveal through the vegetative complex (riparian vegetation), the influences of that water (Franklin and Dyrness 1973, Minore and Smith 1971). These zones are a specialized form of wetland restricted to areas along, adjacent to or contiguous with perennial and intermittently flowing rivers and streams. They may also include periodically flooded lake and reservoir shore areas. This zone is transitional between true bottomland wetlands and upland terrestrial habitats and while associated with water courses, the habitat may extend inland for considerable distances. Recent Coos Bay district field studies of riparian zone widths of coastal mountain streams within the district show they may vary from 80 feet to 600 feet. The weighted mean of these riparian zones was approximately 175 feet. Soils of the riparian zone may not exhibit typical wet soil characteristics of other wetlands. If not, wet soil characteristics will exist close enough to the surface for the water to be used directly by vegetation. This vegetation may range from water loving hydrophytes (such as pond weeds) through terrestrial forms such as western red cedar, cottonwood, big leaf maples and willows.

Riparian vegetation is an integral component of the aquatic ecosystem which provides essential elements to the stream. The vegetation stabilizes streambanks preventing erosion. Vegetation also provides protective cover for

fish and other aquatic organisms. Nutrient cycling of leaves and needles that have captured the sun's energy may be the most important contribution of vegetation to the aquatic ecosystem. The annual nutrient budget of the streams comes directly from the vegetation that is adjacent to the stream. Shade also is an important component of the stream ecosystem provided by the riparian vegetation which maintains the low water temperatures characteristic of most streams in the biome.

Fish

Large indigenous populations of salmon and trout are the principal species of aquatic wildlife utilized in western Oregon. Although these species are most readily recognized they are only a portion of the many species that are found in western Oregon waters. The species that do not fall into the salmon and trout categories are important in the balance of the ecosystem where they maintain the predator-prey relationships among both aquatic and terrestrial species.

Distribution of fishes in western Oregon, as described in this statement, is based on information from Oregon State University, reports of the Pacific Northwest River Basins Commission, and both Basin Investigation reports and Annual Reports of the Fishery Division of the Oregon State Wildlife Commission. Common and scientific names listed are those recommended by the American Fisheries Society.

There are three sub-biomes within the area of the proposed action. The Broad Schlerophyll, the Montane and the Northwest Coastal Coniferous. Although some aquatic species of limited distribution may be found only in one sub-biome, the majority of species are spread across two or all three sub-biomes. The life requirement of each group of species is basically the same regardless of sub-biome and the factors influencing their needs transcend the sub-biomes. Therefore, this description of the existing aquatic environment does not delineate species by sub-biome unless specifically noted.

A checklist of freshwater fishes is shown by sub-biome in table 27. These species occur in waters west of the crest of the Cascade Mountains and part of the Klamath Basin. The greatest number of species inhabit the Northwest Coastal Coniferous Forest sub-biome because it comprises most of western Oregon and has greater diversity of habitat than the other sub-biomes.

Fish Groupings

Fish in Oregon are generally grouped into the following five categories: anadromous fish, cold-water game fish, warm-water game fish, non-game fish, and surf and bay fish. Surf and bay fish are not discussed in this report.

Table 27 - A List of Freshwater Fishes Found in Western Oregon by Sub-biome

Species	NW Coastal Forest	Montane Forest	Broad Sclerophyll	Near Spray Area*
ANADROMOUS SPECIES				
Pacific lamprey (lampetra tridentata)	X	X	X	X
White sturgeon (Acipenser transmontanus)	X	X	X	
American shad (Alosa sapidissima)	X	X	X	
Cutthroat trout (Salmo clarki clarki)	X	X	X	X
Steelhead (Salmo g. gairdneri)	X	X	X	X
Sockeye salmon (Oncorhynchus nerka)	X			
Chum salmon (Oncorhynchus keta)	X			X
Coho salmon (Oncorhynchus kisutch)	X	X	X	X
Chinook salmon (Oncorhynchus tshawytscha)	X	X	X	
Pink salmon (Oncorhynchus gorbuscha)	X			
Eulachon (Thaleichthys pacificus)	X			
Longfin smelt (Spirinchus thaleichthys)	X			
Striped bass (Morone saxatilis)	X			
COLD-WATER GAME SPECIES				
Mountain whitefish (Prosopium williamsoni)	X			X
Brook trout (Salvelinus fontinalis)	X	X	X	
Dolly Varden (Salvelinus malma)	X			X
Cutthroat trout (Salmo clarki)	X	X	X	X
Brown trout (Salmo trutta)	X	X	X	X
Golden trout (Salmo aguabonita)	X			

*Species expected to be found in the immediate proximity, or within 100 feet to 1 mile of some of the proposed spray areas.

Table 27 (Continued)

Species	NW Coastal Forest	Montane Forest	Broad Sclerophyll	Near Spray Area*
COLD-WATER GAME SPECIES (Cont.)				
Rainbow trout (Salmo gairdneri)	X	X	X	X
Kokanee (Oncorhynchus n. kennerlyi)	X	X	X	X
Lost River sucker (Catostomus luxatus)		X		
Burbot (Lota Lota)	X			
WARM-WATER GAME SPECIES				
White catfish (Ictalurus catus)	X			
Channel catfish (Ictalurus punctatus)	X			
Yellow bullhead (Ictalurus natalis)	X			X
Brown bullhead (Ictalurus nebulosus)	X	X	X	X
White crappie (Pomoxis annularis)	X	X	X	X
Black crappie (Pomixis nigromaculatus)	X	X	X	X
Pumpkinseed (Lepomis gibbosus)	X	X	X	X
Bluegill (Lepomis macrochirus)	X	X	X	X
Warmouth (Lepomis gulosus)	X			
Green sunfish (Lepomis cyanellus)	X	X		
Largemouth bass (Micropterus salmoides)	X	X	X	X
Smallmouth bass (Micropterus dolomieui)	X			
Walleye (Stizostedion vitreum vitreum)	X			
Yellow perch (Perca flavescens)	X	X	X	X

Table 27 (Continued)

Species	NW Coastal Forest	Montane Forest	Broad Sclerophyll	Near Spray Area*
NON-GAME SPECIES				
Pit-klamath brook lamprey (Lampetra lethophaga)		X		
River lamprey (Lampetra ayresi)	X			X
Western brook lamprey (Lampetra richardsoni)	X	X	X	X
Mountain sucker (Catostomus platyrhynchus)	X			X
Bridgelip sucker (Catostomus columbianus)		X		
Klamath smallscale sucker (Catostomus rimiculus)		X	X	X
Jenny Creek sucker (Catostomus rimiculus)				X*
Largescale sucker (Catostomus macrocheilus)	X	X	X	X
Klamath largescale sucker (Catostomus synderi)		X	X	X
Shortnose sucker (Chasmistes brevirostris)		X		
Carp (Cyprinus carpio)	X	X	X	X
Tench (Tinca tinca)	X			
Chiselmouth (Acroceilus alutaceus)	X			
Oregon chub (Hybopsis crameri)	X	X	X	
Northern squawfish (Ptychocheilus oregonensis)	X			X
Umpqua squawfish (Ptychocheilus umpquae)	X	X	X	X
Redside shiner (Richardsonius balteatus balteatus)	X	X	X	X
Blue chub (Gila coerulea)		X		
Tui chub (Gila bicolor)		X	X	
Umpqua dace (Rhinichthys evermanni)	X	X	X	X
Longnose dace (Rhinichthys cataractae dulcis)	X			X
Speckled dace (Rhinichthys osculus)	X	X	X	X

Table 27 (Continued)

Species	NW Coastal Forest	Montane Forest	Broad Sclerophyll	Near Spray Area*
NON-GAME SPECIES (Cont.)				
Blackside dace (Rhinichthys o. nublilus)	X	X	X	X
Leopard dace (Rhinichthys falcatus)	X			X
Millicoma dace (Rhinichthys sp.)	X			X
Peamouth (Mylocheilus caurinus)	X			
Rainwater killifish (Lucania parva)	X			
Mosquitofish (Gambusia affinis)	X	X		X
Sand roller (Percopsis transmontana)	X			
Slender sculpin (Cottus tenuis)		X		
Coastrange sculpin (Cottus aleuticus)	X	X	X	X
Klamath Lake sculpin (Cottus princeps)		X		
Prickly sculpin (Cottus asper)	X	X	X	X
Riffle sculpin (Cottus gulosus)	X	X	X	X
Shorthead sculpin (Cottus confusus)	X			X
Torrent sculpin (Cottus rhotheus)	X			X
Mottled sculpin (Cottus bairdi semiscaber)	X			X
Piute sculpin (Cottus beldingi)	X			
Marbled sculpin (Cottus klamathensis)		X		
Reticulate sculpin (Cottos perplexus)	X	X	X	X
Three-spined stickleback (Gasterosteus aculeatus)	X	X	X	X

Cold-Water Game Fish

Cold-water game fish require colder water temperatures (below 70 degrees F) and the best water quality to maintain healthy populations. They are most numerous in streams and lakes of the Coniferous Forest, but occur in all sub-biomes where habitat is suitable. Some coldwater gamefish such as trout, kokanee, whitefish and mullet exhibit seasonal intra-stream migrations for spawning in many stream and lake systems. These migrations add to the complexity of each species life requirements thus emphasizing the need to maintain relatively constant habitat conditions.

Salmon and Trout (Anadromous)

Some of the best anadromous fish habitat on the west coast of North America is located in western Oregon. The Rogue, Umpqua and Willamette Rivers and Tenmile Lakes are notable examples. Other coastal rivers like the Nehalem, Nestucca, Alsea, Coos and Tillamook Bay streams also produce large numbers of fish.

Salmon and anadromous trout are widespread throughout the Coniferous Forest Biome, occurring wherever their access is not blocked by impassable obstructions-either natural (water falls) or man-made (dams or log jams). Because of the life requirements of anadromous fish, special efforts are needed to maintain good quality water in spawning and rearing areas for remaining fish populations. Clean, silt-free gravel is important to many

organisms and especially for salmon and trout spawning. Gravel between 1/2 to 5 inches in diameter is required, depending on the species of fish. Hatching success is drastically reduced by heavy sedimentation of spawning areas.

Young trout and salmon are primarily insect feeders. As they grow and become larger, a greater variety of organisms are eaten, including crustaceans and terrestrial insects that fall into streams. Mature individuals become quite predaceous on small fish, especially Dolly Varden and brown trout. An abundant population of salmonid species is therefore dependent upon a healthy food chain consisting of many small animals that feed on plants in the aquatic and riparian zones. Good water quality and habitat conditions are essential to maintain the food chain.

Warm Water Game Fish

Warm-water game fish such as bass and crappie have been widely introduced throughout western Oregon in all types of aquatic habitat. Various species of this group can be found in stream and lake environments. These species require warmer water temperatures (75 degrees - 85 degrees F) than trout for reproduction. They are also more tolerant of adverse habitat conditions than are salmon and trout, e.g., lower dissolved oxygen concentrations or increased turbidity. They are more prolific than cold-water species and usually cause fishery management problems when introduced into waters managed for trout or salmon production. Because they will thrive in a wide range of habitat conditions and degraded waters, these species provide recreation in some waters unsuited for cold-water fishes.

Non-game Fish

The Oregon chub is the only Hybopsis species native to the Pacific Coast. Other non-game fish with a restricted distribution are the Umpqua dace (Umpqua River and tributaries) and the Umpqua squawfish (Umpqua and Siuslaw Rivers and intervening waters). The river lamprey (Lampetra syresi) occurs only in the Northwest Coastal Coniferous Forest and is uncommon.

However, native non-game species like shiners, dace, suckers, chubs, and squaw-fish, and the introduced carp can cause serious management problems to fishery managers. Populations of non-game fish tend to "explode" and over-populate waters being managed for game fish. In many waters, non-game fish are too competitive (especially for cold-water species), particularly if habitat and water quality conditions are being degraded. Endemic non-game fish are of scientific interest.

Threatened and Endangered Fish

Threatened and endangered fish are cataloged by both the State of Oregon and by the Fish and Wildlife Service. No species of fish is listed by the F&W Service as rare and endangered. Rare and endangered species listed by the State of Oregon indigenous to Oregon west of the Cascades is the Millicoma dace (Rhinichthys sp.) - Coos River; unique. Umpqua squaw fish are unique to the Umpqua basin but are quite abundant. The Jenny Creek sucker presently limited to upper Jenny Creek in the Klamath basin is presently considered status unknown.

Crayfish

Fish are usually considered the most important group of aquatic life because of their direct use to man. Crayfish, a freshwater crustacea is an important aquatic animal utilized by both humans and aquatic organisms for food.

A commercial fishery for crayfish is conducted for two subspecies - Pacifestacus leuisculu leniusculus and P.I. trowbridgii. About 39,000 pounds of crayfish were processed through commercial channels in Oregon during 1970. In many waters recreationists catch them to eat and fishermen use them for bait.

Crayfish are common and environmentally sensitive crustaceans inhabiting most streams, lakes and reservoirs in western Oregon. They provide a source of food for aquatic predators such as mink, Great Blue Heron, cutthroat trout and others. These crustaceans are caught by sport and commercial methods for use as food and fish bait. Their presence usually denotes a relatively unpolluted environment.

Aquatic Invertebrates

The aquatic invertebrates are another major group of aquatic organisms which serve several essential purposes in the stream environment. The primary value of these species such as mayflies, stoneflies and caddis

flies is to process organic material that falls into the stream. These insects capture and convert over 70 percent of all the leaf and needle fall into usable nutrients. This conversion is the way a stream system acquires its annual energy budget from the soil, the sun and the plants. Once the invertebrates convert leaves into masses of living insects they are then converted by fish into energy. Therefore, the aquatic insect community becomes an essential link between the terrestrial nutrients that enter the water and the fish that need these nutrients and man who uses the fish.

Aquatic organisms, as well as the fish, have adapted to good quality water, food and cover. Most organisms of the coniferous biome require stream habitat that is relatively free of fine silt, sand or clays. Benthic organisms, crustacea and aquatic insects require larger substrata such as rocks and gravel. Streams have generally stabilized in heavy forested areas and contain optimum amounts of riffle and pool areas. Most streams develop the aquatic organisms in the faster moving riffle-gravel-rubble areas.

Aquatic Life Water Quality Requirements

The aquatic organisms of the biome, including fish, have all developed and adapted to the environmental conditions of the region. The water quality is one major influencing factor which governs their abundance.

The following water requirements are considered optimum for continuous production of aquatic life:

Dissolved oxygen	7 to 9 ppm
Hydrogen ion (pH)	6.8 to 7.8
Total dissolved solids	125 to 175 ppm
Turbidity	5 or less (summer)
Water temperature	50° to 60° F (summer)

Most streams and rivers at higher elevations produce near neutral water of low temperatures and a fair number of aquatic animals. However, significant changes in water quality may occur at lower elevations. Water temperatures often increase substantially during the summer flow period. Extreme water withdrawals for irrigation in localized areas contribute to higher temperatures and some dry streambeds throughout the biome. These habitat changes are deleterious to trout and salmon but sometimes beneficial to populations of warm-water and non-game species.

Lakes and Reservoir Productivity

The coniferous forest biome contains many important fish-producing lakes and reservoirs. These waters are generally more fertile than rivers and streams unless the basins lose nutrients by periodic flushing. Anadromous, coldwater game, warm water and non-game species are all found in lakes and reservoirs on BLM lands.

Although native runs of anadromous fish have been greatly reduced from historic levels, natural production is still vital to various fisheries

in Oregon. Fish produced in freshwater are caught as adults in the Pacific Ocean, estuaries and main river systems. Coastal lakes provide habitat for salmon, trout and warm-water game fish. There are numerous reservoirs in the Willamette system now creating habitat for various species, depending on the characteristics of each reservoir.

The northwest forest sub-biome surrounds many important estuaries on the Pacific Coast where freshwater from the forest drainages meet and intermix with the salt water of the ocean. These estuaries support a variety of marine species and juvenile life stages of anadromous fish. Coos Bay and Tillamook Bay are examples of larger well developed estuaries. Estuarine shellfish are among the most important species to man and the most sensitive to pollution. Estuarine shellfish species most important to man are:

Dungeness crabs (Cancer magister) are numerous in most bays and they are eagerly sought as a sport catch. This species also supports an important commercial fishery.

The native oyster (Ostrea lurida) and Japanese oyster (Crassostrea gigas) are cultured by private oyster growers in some estuaries.

Razor clams (Siliqua patula) are abundant on the Clatsop County beaches. Only a few isolated populations of razor clams occur on other beaches. Bay clams are abundant in certain areas of some coastal bays. (Clinocardium nuttalli), softshell clam (Mya areanaria), butter clam (Saxidomus giganteus), and Littleneck clam (Protothaca staminea).

Bay and razor clams, ghost shrimp (Callianassa), and mud shrimp (Upogebia) are sold commercially. Populations of bay and razor clams support very intensive sport digging. Sport fishermen commonly dig shrimp for fish bait.

Although these sensitive aquatic organisms can be damaged by pollutants, the massive exchange of salt water from the ocean has acted as a protection by diluting such pollutants as oil, pulp liquors, sewage and other chemicals. At present, estuarine species are abundant and appear in no danger due to improving water quality resulting from enforcement of new pollution abatement laws.

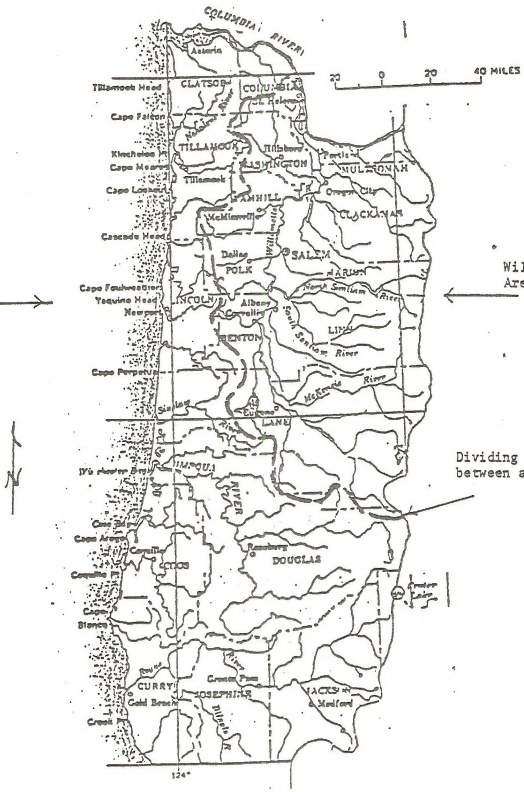
WATER

The characteristics of the water resource vary markedly across Oregon, and the boundaries for areas with similar characteristics will differ from those of the sub-biomes. The two areas of Oregon used in this section for describing the water resource were adapted, except as noted, from the Columbia-North Pacific Region Comprehensive Framework Study. The quality and quantity of surface water and ground water will be discussed for each area.

Figure 6 is an index map showing the major drainage areas. These areas drain forest lands including the 74,436 acres proposed annually for herbicide treatment. The acreage proposed for treatment is .4 of 1 percent of the total drainage area.

Figure 6

Western Oregon
(Major drainage areas)



Coastal Area

The Coastal Area extends from the southern border of Oregon about 350 miles to the northern border of Oregon.

It includes the drainage areas of all streams, except the Columbia, which flow directly into the Pacific Ocean or the Columbia estuary. The area extends inland to include all of the Umpqua, and Rogue River drainages, which provide marked contrast to the Coastal areas.

The total area is 17,294 square miles. The total land and water area is:

	Acres	Square Miles
Water Area	83,400	130.3
Land Area	10,984,500	17,163.2
Total Area	11,067,900	17,293.5

An outstanding feature of the coastal area is the mild, moist climate. The inland areas of the Rogue and Umpqua Rivers have a considerably more variable climate, which is drier and warmer. The coastal fringe has a small temperature range with extremes rarely occurring. Average annual precipitation generally ranges from 60 to 200 inches, most of which falls in the form of rain from November through March, with little rainfall in July or August. The

interior valleys of southern Oregon have experienced minimum winter temperatures of zero degrees and summer maximum temperatures of 110 degrees. Precipitation totals range from 20 to 50 inches. Although significantly less than the coast, the same general rainfall pattern is evident. Winter rainfall is the major source of runoff, particularly in the northern portion, with a secondary source from snowmelt in the Upper Umpqua and Rogue Basins. Those streams with rainfall as the main source of runoff have a seasonal peak from December to January and a seasonal low in August. Those streams whose runoff is supplemented by snowmelt have a secondary peak in May and June.

The average annual runoff amounts to 53,310 cfs. (North Coast, 1961; Midcoast, 1965; South Coast, 1963; Framework Study; 1970).

The quality of the surface waters is generally very good; the streams are very dilute and very soft. In the northern portion, the total dissolved solids range from about 30 to 50 mg/l, with the range in hardness from 8 to 30 mg/l with calcium and bicarbonate as the major ions. Some of the lower tributaries of the Rogue River contain water with a higher portion of magnesium bicarbonate. The total dissolved solid load in the coastal area is unknown.

Suspended sediment yield from the coastal area is generally low. About 89 percent of the area yields 0.1 to 0.2 acre feet per square mile per year. Portions of the Upper Rogue yield 0.02 to 0.1 acre-feet per square mile per year and areas around the Upper South Fork of the Umpqua, the South Fork of the Coquille River, and the Upper Wilson River yield 0.2 to 0.5 acre-feet per square mile per year.

Major impoundments in this subregion include Lost Creek and Emigrant Reservoirs on the Rogue River system. In addition, there are a number of small power reservoirs in the Umpqua and Rogue River Basins. Except for the Rogue and Umpqua Rivers, only a small amount of water is utilized for the generation of hydroelectric power.

Most of the coastal area is classified as yielding 1 to 20 gallons per minute of ground water to a well. An exception is the southwestern west slope of the Cascade Mountains whose ground water yield is unknown but which is underlain by volcanic material capable of yielding moderate to large supplies in the higher elevations and small to moderate supplies in the lower elevations. The best aquifers are the alluvial deposits along the major streams and beach deposits. These sites may yield from 20 to 500 gallons per minute.

Ground water generally has naturally occurring dissolved solids concentration of from very low levels up to 500 mg/l. Commonly, more highly mineralized water is encountered at depths of several hundred feet. A few coastal area wells have encountered saline water at depths of less than 100 feet.

Willamette Area

The Willamette Area lies entirely within the State of Oregon, occupying the Willamette and Sandy River drainages (figure 6). The Columbia River is the northern boundary, while the crest of the Cascade Range, the Coast Range,

and the Calapooya Mountains make up eastern, western, and southern boundaries respectively.

The total area is 12,046 square miles. The total land and water area is:

	Acres	Square Miles
Water Area	106,400	166.3
Land Area	7,602,800	11,879.4
Total Area	7,709,200	12,045.7

The major streams include the Nehalem, Wilson, Trask, Tillamook, Nestucca, Siletz, Yaquina, Alsea, Siuslaw, Umpqua, Coos, Coquille, Rogue, and Chetco Rivers. Small perennial streams abound because of the high annual precipitation; however, their summer flow is low due to prolonged rainless periods.

The major stream is the Willamette River, formed by the confluence of the Coast and Middle Forks about 2 miles south of Eugene. It has a total length of approximately 187 miles and, for most of this distance, meanders northward through the central part of the Willamette Valley. At Oregon City, it plunges over a 50-foot falls and then proceeds north to join the Columbia just north of Portland. The principal tributaries are from the east side and include the Middle Fork, McKenzie, Santiam, Molalla, and Clackamas Rivers. Major tributaries from the west are the Coast Fork, Long Tom, Luckiamute, Yamhill, and Tualatin Rivers. The Sandy River enters the Columbia upstream from the Willamette.

Streams which enter the Willamette River from the Coast Range (west side of the valley) have distinctly different hydrograph slopes than the streams from the Cascade Mountains (east side of the valley).

The west side streams have their peak flow period from December through January, as a result of heavy winter rains. Rainfall on the crest of the Coast Range averages from 100 to 200 inches per year in the northern part, and decreases to 60 to 90 inches per year in the southern portion. On the east side of the valley, winter snowpack may form part of the yearly runoff and may cause a second peak flow period from these streams during April and May.

Rainfall in combination with smaller amounts of snowmelt comprises most streamflow. Average annual runoff amounts to about 38,490 cfs (cubic feet per second), of which 1.4 per cent is consumed.

The natural quality of surface water in the Willamette area is generally good with the dissolved solids content ranging from 38 mg/l to about 95 mg/l. The surface waters contain ions of the calcium magnesium bicarbonate type. Of particular significance is the lack of an increase in the salt since the earliest chemical analyses in 1910. This low salt load (about 0.02 ton/acre/year) is due in part to the humid zone and the well leached soils that contain only small quantities of soluble salts. The total dissolved solid load for the Willamette basin is estimated to be about 0.28 ton/acre/year.

About 80 per cent of the annual sediment discharge occurs during the high rainfall and high runoff period from November to February. About 90 per cent of the area yields from 0.1 to 0.2 acre-feet/square mile per year. Suspended sediment concentrations for large streams range from less than 100 mg/l to about 400 mg/l, but may exceed 2,000 mg/l during major floods.

Perhaps 65 per cent of the Willamette area is underlain by geologic material which yields ground water from 1 to 20 gallons per minute to wells. Yield from the volcanic rocks of the Cascade Mountains is generally unknown, however, the character of streamflow in this region indicates yield to wells may be moderate to large. The best aquifers are found in the alluvial deposits of the Willamette River and its major tributaries. This material will yield 20 to 500 gallons per minute.

Ground water quality is generally good in the Willamette area with low fluoride and boron concentrations and low sodium absorption ratio. Iron concentrations may be in excess of recommended limits in some wells. Most ground water has dissolved solids concentrations of less than 500 mg/l. Water from marine strata may be moderately to highly saline at depth of a few hundred feet. In a few places, saline water may be encountered at less than 100 feet.

Herbicide Analysis

Water quality sampling is being conducted by several governmental agencies at various locations. Generally these locations are in some of the more important water courses.

The "Catalog of Federal Pesticide Monitoring Activities in Effect July 1972" was put together by the Federal Working Group on Pesticide Management, Washington, DC, March 1975. Resulting pesticide monitoring data was placed in the U.S. Geological Survey "WATSTORE" computer system. Water samples were integrated with a standard suspended sediment sampler. Bottom sediment material was also sampled from the top fresh deposited sediments at some sites. Continued monitoring is continuing for base line data information to establish a reference point to relate changes resulting from uptream activities.

The water monitoring stations established in main drainages have yielded the following information about herbicides in the existing water resources at a point in time. These data reflect upstream contamination from all sources (see tables 28 and 29).

VISUAL RESOURCES

Visual resources are the land, water, vegetation, man made features and wildlife. Visual resource values are assessed by the Bureau's visual resource management program. Characteristic landscapes, scenic quality

TABLE 28

Herbicide Analyses, integrated flow

	Total 2,4-D (ppb)*	Total 2,4,5-T (ppb)	Total Silvex (ppb)	Total Atrazine (ppb)	Total Simazine (ppb)
Coastal Area					
Station No. 14301000 Nehalem River near Foss, Oregon					
May 26, 76	none**	none	none	none	—
Aug 19, 76	none	none	none	none	none
Nov 22, 76	none	none	none	none	none
Feb 24, 77	none	none	none	none	none
Jun 2, 77	none	none	none	none	none
Sep 9, 77	none	none	none	none	none
Station No. 14312260 South Umpqua River near Roseburg, Oregon					
Oct 22, 75	.00	.00	.01	—	—
Jan 22, 76	.00	.00	.00	—	—
Apr 16, 76	.00	.00	.00	—	—
Jul 22, 76	.01	.00	.00	—	—
Oct 20, 76	.00	.00	.00	—	—
Jan 6, 77	.00	.09	.00	—	—
Apr 20, 77	.00	.00	.00	—	—
Jul 26, 77	.05	.04	.00	—	—
Station No. 14372300 Rogue River Near Agness, Oregon					
May 20, 76	none	none	none	none	none
Aug 18, 76	none	none	none	none	none
Nov 17, 76	none	none	none	none	none
Feb 24, 77	none	none	none	none	.58
May 17, 77	none	none	none	none	none
Aug 24, 77	none	none	none	none	none
Willamette Area					
Station no. 14207500 Tualatin River at West Linn, Oregon					
May 27, 76	none	—	—	—	none
Aug 20, 76	none	none	none	none	none
Nov 23, 76	none	none	none	none	none
Feb 16, 77	none	none	none	none	none
Jun 1, 77	none	none	none	none	none
Sep 6, 77	none	none	none	none	.66

* The source (USGS) reported these values in micro grams per letter (UG/L) rather than parts per billion (ppb). The two values are essentially the same at these small concentrations.

**None signifies specifically looked for but not detected.

Source: Computer printout from the USGS "WATSTORE" system for western Oregon

TABLE 29

Herbicide Analyses, bottom sediment material

	Total 2,4-D (UG/KG)	Total 2,4,5-T (UG/KG)	Total Silvex (UG/KG)	Total Atrazine (UG/KG)	Total Simazine (UG/KG)
Coastal Area					
Station No. 14301000 Nehalem River near Foss, Oregon					
May 26, 76	*none	none	none	none	none
Nov 22, 76	none	none	none	none	none
Station No. 14372300 Rogue River Near Agness, Oregon					
May 20, 76	none	none	none	none	none
Willamette Area					
Station no. 14207500 Tualatin River at West Linn, Oregon					
May 26, 76	none	none	none	none	none
Nov 22, 76	none	none	none	none	none

* None signifies specifically looked for but not detected.

Source: Computer printout from the USGS "WATSTORE" system for western Oregon.

by physiographic region, public sensitivity, and distance influence zones as evaluated by interdisciplinary teams determine the potential visual resource values in each sub-biome.

Characteristic Landscapes

Coast Range - The Coast Range provides a long narrow belt of hilly and low mountainous land extending from the Columbia River to the Coquille River fronting the Pacific Ocean. It is a unique landform of sandy ocean beaches, shifting sand dunes, marine and river terraces, and rugged windswept headlands. The interior is made up of many steepsloped hills and ridges. Prominent points are Mary's Peak (1249M), Saddle Mountain (995M) and Roman Nose (892M). Heavy rainfall contributes to dense forest vegetation. U.S. Highway 101 is the major access route. Prominent features are the National Dunes Recreation Area, Cape Argo, Haceta Head, Cape Perpetua, Yaquina Head and Cascade Head.

Class "A" scenic quality is typified by Pacific Ocean wind swept forest headlands with sandy beaches, deep river gorges and coastal plain and sand dune water bodies.

Klamath Mountains - The Klamath Mountain province extends south from the Coquille River into California. It is a compact rugged mass higher than the Coast Range including Mount Ashland (2295M). The ridges are moderately glaciated having rugged rock outcrops. The summits drop off abruptly to the

west in a series of spectacular rugged headlands and sea stacks along the Pacific Ocean. Prominent features include the Rogue Wild and Scenic River and the Oregon Caves National Monument. Highways 101 and 199 provide major access to the area.

Willamette Valley - The major humid lowland in Oregon. It is an alluvial plain 160 miles long by 65 miles wide, framed by the Willamette River. Land use is predominately agricultural in a rural setting. Prominent features are the Willamette river and the forest background enframement of the mountainous Coast Range on the west and the Cascade Range on the east.

Class A scenic quality is associated with lush forest land river drainages and water bodies.

Western Cascades - A mountainous region of many steep east-west ridges deeply dissected by tributaries of the Clackamas, Santiam, McKenzie, Umpqua, and Willamette Rivers. The region is characterized by a highly productive forest resource. Forest recreation is a major land use. Prominent features are the scenic river gorges cited above.

Class A scenic quality is associated with mountainous forest river drainages and water bodies.

High Cascades - A volcanic glaciated mountainous region whose ridges run north to south extending from Washington into California. Prominent mountain

peaks include Mt. Hood (11,235'), Mt. Jefferson (10,490), Three Sisters (10,358'), Mt. Scott (8,926') and Mt. McLoughlin (9,493'). Prominent features are Crater Lake National Park which is a hugh caldera caused by the collapse of Mt. Mazama, Columbia River Gorge, wilderness areas, and the National Pacific Crest Trail.

General land use is forest-recreation. Class "A" scenic quality is associated with bare and snow covered mountain peaks, water bodies with forest vegetation, and river gorges.

Data Gap

Fifty per cent of the Bureau's western Oregon lands have not been inventoried or evaluated for visual resource values and 80 per cent have not had program management objectives developed to advise land managers of necessary protection, maintenance, rehabilitation and enhancement measures.

MAN

The influence of man in the existing environment is largely reflected by land use, socio-economic factors, recreation and sensitivity to changes in the environment.

Land Use

Although some early settlement had taken place in the southwest on Spanish land grants, it was only after the west became the United States Territory, in 1846 and 1848, that the cross-country movement of pioneers gained momentum and the development of the West began.

Landform was the primary determinant of early settlement patterns. After crossing mountain saddles, the pioneers usually followed the rivers and valleys and spread out in the basins and plains. They preferred river banks and adjacent uplands for settlement. The rivers provided transportation and the trees growing nearby provided wood for home construction and fuel.

Settlement gained momentum when the vanguard of settlers reached the plains. Settlement and development of the public domain was further facilitated through passage of various public land laws. These laws were designed to provide title to tracts of land, varying in size from 160 to 640 acres, upon compliance with occupancy and use conditions.

Settlement, however, was only the initial step in development. Settlers who had located on the land could not remain isolated members of society. They were followed closely by churches and schools. Frontier towns and trading centers sprang up over the country. Travel to the West was greatly facilitated when, in 1869, the central transcontinental railroad was opened.

Montane Coniferous Forest. Although settlement and development took place readily in the more fertile valleys and plains, the establishment of permanent settlements in the mountainous terrain that comprises the Montane sub-biome took place in a much different fashion. Characterized by steep, rugged topography with shallow, poorly developed soils, the mountains afforded little opportunity for homesteading. Exceptions occurred in sheltered fertile valleys between the ranges. Mining of gold and silver, and later timber harvesting, were the principal attractions of the western mountains.

The rugged western portion of the Cascade Range in the sub-biome is sparsely populated. The area is important as a supplier of water, timber, and other materials to the adjacent lowlands.

Communities tend to be small, and are economically oriented to logging, agriculture or ranching, mining, and more recently, tourism. A phenomenon that began after World War II and has increased at a rapid rate in some parts of the region having non-existent or weak local land use controls has been the development of "speculative" homesites. Frequently located in remote rural areas, these recreation sub-divisions more often than not have failed to develop as portrayed in the sales brochures. Large National Forests and parks in the area have virtually no permanent inhabitants.

Northwest Coastal Coniferous Forest. The history of early settlement of the coastal forest region followed essentially the same pattern as the Montane region to the east. Although rough and mountainous for

the most part, the region contains some of the most productive softwood forests in the United States. Often referred to as the Douglas-fir Region, for the principal tree species found there. Other valued softwoods are cedar, hemlock, spruce, and true firs.

The gold rush and subsequent population growth in California afforded the first export market for the region's vast supply of mature timber. This market expanded into the developing Midwest with the extension of intercontinental railroads into the Pacific Northwest in the 1880's and 1890's. Production of wood products for a national market was the single most significant economic factor contributing to the rapid population growth of the region into the 1920's.

The older alluvial fill of the Willamette and Tualatin Valleys provided rich soil for eager pioneer farmers. Soon agricultural products were finding their way downstream and overland to the City of Portland. Sited at the confluence of the Willamette and Columbia Rivers, the city became an important center of trade and transportation at an early date.

Farmers cleared valley land leaving extensive woodland only along stream courses; a frame of green for the many grain farms, dairy farms and orchards. The excellent farming country supported new population centers at Cottage Grove, Eugene, Corvallis, and Salem.

The forested Coast Range landscape consists of various forest types intermingled with cut-overs, burns, and cleared land. The area is now lightly settled (population density, 1 person to 400 acres) with individual farms producing hay, fruit crops, or dairy pasture (Atlas of Oregon, 1976).

Population (population density, 2-5 persons per 100 acres) is concentrated along the level land of coastal terraces, and beside stream and river estuaries. Coastal lakes are an important source of water for coastal towns.

The recreation-residential development industry has opened coastal territory to relatively concentrated occupation in the summer months. Older settlements occur at ports and estuaries where logging and fishing activities are the economic mainstay.

Socio-Economic Factors

Although most of the forest lands within the Montane Coniferous Forest are inside National Forests, and are administered by the Forest Service, the BLM administers 1,631,000 acres of commercial forest on the public land within the region, from which $1,808,000 was received from sale of timber in 1971. Excluded from these figures are the O&C lands administered by the BLM in Jackson and Josephine Counties in Oregon. Although they are within the Montane sub-biome, O&C land data pertaining to them are included with the other O&C Counties under the Coastal sub-biome section.

Lumbering and livestock grazing occur generally throughout the Montane sub-biome, during the fall and winter.

Recreation-tourism is growing rapidly in importance throughout the sub-biome. The Pacific Crest Trail, routed along the crest of the Cascade Mountains, stretching from Canada to Mexico, leads to points of scenic beauty accessible only by pack horse or foot and annually receives increased use. Throughout the Montane region, Federal, state, county, and municipal organizations as well as private enterprises have been active in the development of scenic and recreation resources. Hunting, fishing, sightseeing, picnicking and camping, and winter sports are the predominant types of recreation activities.

Lumbering and wood products industries continue to play an important role in the economy. In 1968 the Pacific Northwest Forest and Range Experiment Station estimated the degree of economic dependency upon timber industries of selected areas within the Douglas fir Region of Washington, Oregon and California. Dependency was measured as a percent of total economic (or export) base employment attributable to timber dependent industries. The researchers found that timber dependent industries accounted for approximately 45 percent of the region's economic base employment. Table 30 shows timber-dependency ratings for 8 economic areas within the region. During 1971 approximately 1.23 billion board feet of timber worth $52 million were sold from 1.9 million acres of O&C land in Oregon. From this, $31.8 million were distributed to the 18 O&C counties under terms of the O&C Act of 1937 and

Table 30 - Classification of Economic Areas by Degree of Dependency upon Timber-Based Employment

Dependency	Economic Area*	Percentage of 1960 excess employment dependent on timber-based employment
Slight	Portland	23.8
	Salem	29.3
Moderate	Astoria	63.1
High	Medford	70.0
	Corvallis	74.3
	Eugene	76.6
	Coos Bay	91.6
	Roseburg	99.4

*Economic areas are identified by the names of their respective growth centers.

Note: The authors used the excess-employment technique to determine the portion of employment in an area which was engaged in economic base activities. This approach considers any industry in an area with employment in excess of the national norm for distribution of employment among industries to be producing for export. The percentage of total excess (export) employment (the total may include several industries, basis as well as service, for an area) attributable to timber related industries is computed and defined as the timber-dependency indicator (figures in the right-hand column of the table).

subsequent agreements. Receipts for Fiscal Year 1972 on a volume of 1.19 billion board feet were $65.5 million of which $37.7 million were distributed to the counties (receipts to the counties include revenues from sale of timber from O&C lands (the largest source), grazing fees, mineral fees, rental and sales of land, and from other sources).

The O&C lands contribute 17.5 percent of the timber harvest in western Oregon. In this same area timber-dependent industries account for 45 percent of the total economic base employment. This dependency ranges from a low of 24 percent in the Portland area to 99 percent in the Roseburg area. Thus the O&C lands contribute approximately 8 percent of the total western Oregon economic base employment. The significance of these lands to local and regional economies is further exemplified by the fact that 17 per cent (13,500) of the 78,000 persons employed in the lumber and wood products industry in western Oregon in 1965 could attribute their jobs to the O&C timber cut. Payrolls were $89.5 million and the value added to the economy, including the value of the timber cut, was $187.1 million. This compares with the value of total products sold on farms of the 18 counties of $245 million. It is greater than the value added by any other Oregon industry, with the exception of the total lumber and wood products industry.

These jobs in the basic industry in turn generated more than 20,000 other secondary employment jobs (retail, service,and other employees serving the basic employees), and supported a total population of about 80,000 (including the employees and their families).

Recreation

The Pacific Coast forms the western boundary of the Coastal sub-biome. The proximity to the ocean adds to the recreational diversity of the area. Outdoor activities such as swimming, fishing and camping are some of the more common forms of recreation activity. Digging clams, both commercially and as a form of recreation, takes place on the beaches and inlets all along the coast. Numerous streams that traverse the coastal strip, many on BLM administered lands including such nationally known ones as the Rogue and Umpqua, yield exciting freshwater catches. Saltwater sportfishing has created and supports a growing charter boat industry.

Most of BLM administered land in the Coastal sub-biome is available to the public for hunting. Since much of the area is covered by a dense forest, most of the hunting is concentrated in natural or man-made openings such as roads, timber harvest sites or cleared utility rights-of-way.

Public lands (O&C) administered by the Bureau in western Oregon received an estimated 11.8 million recreation visits in 1976 for sightseeing, fishing, hunting, rockhounding, ORV operation, white water river running, hiking, nature study, natural food collecting, picnicking and camping at the 56 developed recreation sites currently operated in cooperation with the O&C counties.

Outstanding recreational features include the Rogue National Wild and Scenic River and Trail, Pacific Crest Trail, Hyatt Lake Recreation Site, Loon Lake Recreation Site, Shotgun Recreation Site, Fishermens Bend Recreation Site, and Wildwood Recreation Site.

Cultural Resources

Early man's entry into the New World from Asia via a Bering Strait land bridge, estimated to be 1000 miles wide when the seas were at their lowest, is believed to have occurred between 20 and 40 thousand years ago. Radio-carbon dated remains going back to about 10,000 B.C. show well developed stone chipping techniques and hunting skills adapted to the taking of large animals. Most evidence comes from game kill sites and stratified cave deposits.

The Northwest Coastal Conifer Forest was the home of the Northwest Coast culture. Essentially a river or river mouth culture, oriented around salmon fishing, the Northwest Coast culture is noteworthy for its vigorous and distinctive art and great use of wood. Village sites were located along streams and near sheltered inlets along the coast that may attract a suspected site.

Scattered throughout the coastal forest are remainders of the region's early history. Old mining and logging camps, remnants of military posts, and preserved homes of early pioneers are some examples. For instance, Champoeg, near Newberg, was the site of the vote establishing a provisional government

in Oregon until Congress would extend its jurisdiction. This was the first American government to be established west of Iowa. Today Champoeg is a state park.

SENSITIVE AREAS

Residents of agricultural lands adjacent to public lands are extremely sensitive to the use of herbicides on public forest lands. Aerially applied herbicides can injure or kill valuable agricultural crops on adjacent land if drift control techniques and other protective methods are not effectively employed or through application accidents.

Fish hatcheries, municipal and domestic water users located close to proposed project areas also express concern and lack of knowledge about the toxicity of herbicides if they are not fully informed about proposed spray plans. These people are concerned about impacts on concentrations of hatchery fish, fish in private ponds, and direct effects on human health from contaminated water.

Residences, agricultural land, and known domestic water intakes and fish hatcheries that are located within .5 and 1.0 mile respectively of proposed 1978 project areas consisting of about 1,836 treatment units are shown on maps in Appendix D and summarized below.

Sensitive Areas	Number
Agriculture land and residences	188
Domestic water intakes	39
Fish hatchery	4

The herbicide, Silvex, is one of two phenoxy compounds containing a contaminant called TCDD (Dioxin). Public controversy has developed over the inferences relating to human health that can be drawn from the results of research on this contaminant. "TCDD is an unavoidable contaminant in all pesticide products in which 2,4,5-trichloro phenol is used as a manufacturing intermediate. Its concentration in Silvex is regulated by mutual consent among manufacturers at 0.1 mg/kg of Silvex acid, at which concentration its contribution to toxic hazard is well below that of Silvex despite its extreme obsolute toxicity in its pure form" (EPA, 1977).

DESCRIPTION OF THE FUTURE ENVIRONMENT

The following description of the future environment of the three major biomes in western Oregon ten years from now is based in the assumption that the proposed project will not be implemented in any form.

Terrestrial Vegetation

The plant community as a result of plant successon following logging or fire in the coniferous forest zones will be visibly different without project

implementation. Grass, ferns, and brush species will be dominant on most harvested areas. Conifers will be sparse in number and often found in a subordinate position in relation to overtopping brush species.

Terrestrial Wildlife

Due to the dynamic nature of the forest community, some changes in the numbers, diversity and distribution of wildlife can be expected within the next ten years. This change will be affected by non-implementation of the proposed project to the extent that brush loving species (birds and animals) will utilize harvested coniferous forest lands to a greater extent.

Soil

Soil properties and characteristics are expected to remain unchanged within the next ten years. A small amount of soil erosion may not take place without implementation of the proposed action.

Aquatic Organisms

Growth of aquatic vegetation, especially riparian vegetation along streams located in areas of timber harvest will improve conditions for aquatic organisms such as fish and insects.

Water

The quality of surface and ground water is expected to be maintained or improve throughout all three of the biomes in western Oregon. The quantity of water now occurring as surface run-off from timber harvest areas may diminish by a small though unquantifiable amount as vegetation increasingly occupies areas where timber has been harvested. This vegetation can be expected to use water through transportation, interception and evaporation processes (Brown, 1972).

Visual Resources

Some trade-off of values may occur in visual resources if herbicides are not used. Vegetation that will occur on timber harvest areas that are exposed to view will be largely deciduous brush, trees and low growing evergreen ferns, salal, manzanita, and others. Plantations of coniferous forest trees commonly seen at present will be rare. Plantations that occur will be generally thinly stocked with trees.

Man

Impacts of non-implementation on man will be most obvious in terms of socio-economic impacts. The annual timber sale volumes now offered for sale are based on projections of future timber production that requires successful vegetation management leading to a prompt and adequate level of

reforestation. Non-use of herbicides or other methods of vegetation control will lead to a decrease in the commercial productivity of the forest lands proposed for treatment. The decrease is estimated at 30-50 percent (U.S. Forest Service, 1976) in the annual average timber volumes projected as available for sale assuming effective vegetation management. Income to the O&C counties, jobs and payrolls would be reduced proportionately to those described for the existing environment.

Environmentally Sensitive Areas

Herbicide use is expected to continue on adjacent public and private lands. Sensitivity to this use by certain public groups or individuals will continue.

CHAPTER III

ENVIRONMENTAL IMPACTS OF THE PROPOSED ACTION

BACKGROUND

The administrator of the Environmental Protection Agency (EPA) registers a pesticide (herbicide) when he determines that when considered with any restrictions:

> ...(c) it will perform its intended function without unreasonable adverse impacts on the environment; and (d) when used in accordance with widespread and commonly recognized practice it will not generally cause unreasonable adverse impacts on the environment. (P.L. 92-516, Federal Environmental Pesticide Control Act of 1972).

The Environmental Protection Agency has a procedure established by the Federal Pesticide Environmental Control Act of 1972 for examining new research findings about registered pesticides. This procedure is called rebutable presumption against registration (RPAR). Based on the findings, the administrator may cancel the registration, impose restrictions on its use, or change its classification. The herbicides 2,4,5-T and Silvex are currently undergoing examination by EPA because of potential hazards of a contaminant called TCDD (Dioxin). EPA has established a TCDD (Dioxin) monitoring committee to keep abreast of and interpret research results relating to this contaminant.

On April 21, 1978, the EPA published a "Notice of Rebuttable Presumption" in the federal register concerning 2,4,5-T. Although the Bureau does not use this chemical, it is closely related to Silvex, a herbicide included in the Bureau's proposed action described in Chapter I.

The "RPAR" notice requests registrants and all other interested persons to submit rebuttals and other information on the presumption and to submit any other data on the risks and benefits of 2,4,5-T. Such data is required within a certain time frame. In the case of 2,4,5-T, the deadline is August 4, 1978.

Information on the status of the 2,4,5-T "RPAR" process can be obtained from:

Harvey Warnick
Office of Special Pesticide Reviews
Office of Pesticide Programs (WH-566) Room 447
East Tower, EPA
401 M Street, SW.
Washington, DC 20460

Herbicides proposed for use by the Bureau in western Oregon are all registered by EPA and are in widespread and common use. However, it is recognized that registration by EPA is not a guarantee of safety but only reflects man's best efforts to analyze and interpret environmental impacts at any point in time. If as a result of the RPAR process, EPA revises registrations so that additional restrictions in the use of a herbicide, such revisions will quickly be adopted by the Bureau.

INTRODUCTION

This chapter contains a discussion of the impacts of the proposed action on the environment components described in Chapter II and identifies those impacts that may remain if the proposed action is implemented with the project design features described in Chapter I.

The impacts of the herbicides proposed for use are discussed by individual western Oregon sub-biome where information of this specificity is available. Unless otherwise indicated, the impacts are assumed to apply to all three sub-biomes.

The herbicides proposed for use are all registered with EPA. However, to meet the requirements of the National Environmental Policy Act (NEPA) these herbicides have been analyzed for the environmental impacts of western Oregon forest land applications by an interdisciplinary team composed of Bureau professional natural resource specialists in Oregon.

The extent of the analysis was limited to reviews of available research results or summations thereof and the Bureau's: 1) Timber management ES (1975); 2) Western Oregon Timber Management EAR 1974; 3) Western Oregon district herbicide program EARs, 1976; and 4) a 1978 U.S. Forest Service Environmental Statement that addresses Vegetation Management with herbicides (Region 6). These documents are all identified in the bibliography. The research results analyzed are considered representative.

The herbicides proposed for use include: 2,4-D, Silvex, Simazine, Atrazine, Diuron, Tordon, Dalapon, Banvel, Krenite, and Round-up. In 1978 these are proposed for use on 74,436 acres of the public land administered by the Bureau in western Oregon. More than one-half of the proposed program for 1978 involves the use of Silvex (42,000 acres).

An annual herbicide program averaging about 74,500 acres is projected for the next decade.

TERRESTRIAL VEGETATION

The proposed action will impact some components of the vegetation on 74,500 acres annually of the 1.9 million acres of BLM commercial forest land in Western Oregon. Table 7 (Chapter 1) shows the specific acreage of each type of vegetation planned for control by designated herbicides in 1978. Impacts to vegetation are, for the most part, intentional and direct. In 1978, 17,245 acres of the seral stages dominated by grass and 54,446 acres of the stages dominated by brush are proposed for treatment. An additional 2,545 treatment acres contain mixtures of early seral and introduced vegetation along roads. Tansy ragwort alone is the target in 200 acres.

Total acreage requiring herbicide treatements over the next 10 years will be approximately 745,000. This includes second and third treatments on some areas. Most herbicide treatments will continue to be on acres harvested for timber. The treatment areas are scattered throughout the three sub-biomes

and this scattering of treatments will be the general pattern over time as shown in Appendix D. The necessity for herbicide treatments will depend on the competition of target plants with young conifers.

Herbicides are variously used to manipulate species composition, size, density, vigor and presence of vegetation. Their use in forestry is to accelerate plant succession from stages dominated by grass or brush to stages dominated by conifers. Acceleration of seral changes is a desired consequence of the decision to intensively manage the forest for timber production. Acceleration occurs by selective limitation of competition from early seral plants. While the species of later seral stages are eventually competitively successful, they do not necessarily require the early stages to prepare or modify the environment for them (Oosting, 1956). However, the chemical removal or modification of intermediate brush successional stages for site preparation without a complete, successful follow-up reforestation effort has the effect of reversing succession to an earlier grass stage (Lewis and Conn, 1956).

The characteristics of the herbicides proposed for use (table 31) are analyzed in relation to the characteristics of the plant species to be treated. From this analysis an effective herbicidal vegetation management program is developed that is often only an integral part of follow on reforestation efforts.

Table 31

Summary of Herbicide Characteristics Used In Foreatry

Herbicide	Formulation	Season of Application	Carrier and Volume	Application Rate	Selectivity	Relative Persistence	Use Precautions	Route of uptake	Cost ($/lb or $/gal)
2,4-D	Amine	Spring and summer	None	Undiluted or 1:1 with water 4 lb ai/A	Hardwoods except cherry and bigleaf maple by injection	Short	LD50-375 mg/kg	Cut surface	$6.50 gal. at 4 lb ae/gal.
	Low volatile eatera (Isooctyl, BOE, PGBE)	Late winter to summer	5-20 gal/A in diesel, water or oil-in-water	1/4-3/4 gal/A 1/3 bl ae/A	Shrubs, weed trees and forbs; for site preparation and conifer release (except pines)	Short		Stem & foliage	$8/gal at 4 lb ae/gal.
	Amine	Spring to late summer	None	Undiluted or 1:1 with water	Hardwoods by injection	Short		Cut Surface	$19/gal at 4 lb ae/gal
Silvex	Low-volatile eaters (BOE, PGBE)	Late winter to summer	10 gal/A in diesel, water, or oil-in-water emulsion	1/4 to 3/4 gal/A 1-3 lbs ai/A	Shrubs, weed trees & forbs; slightly more damaging to conifers than 2,4-D or 2,4,5-T	Mod.	Silvex is not a direct substitute for 2,4,5-T LD50-375 mg/kg	Stem & foliage	$18/gal at 4 lb ae/gal
Picloram	Potassium salt + invert emulsions of 2,4-D	Spring to mid-summer	15-25 gal/A invert emulsion	1 to 4 qts. picloram + 1 to 4 gal of phenoxy invert; 1/8-1/2 lb ai/A picloram with 2-8 lb ai/A of phenoxy	Shrubs and weed trees for site preparation	Long	Delay planting 8 months; must be used with Dow invert emulsions; LD50-8200 mg/kg	Foliage	$60/gal + invert
	Triisopropanolamine salts of picloram & 2,4-D (Tordon (Tordon 101R and Tordon 101)	All	None	Undiluted 2-1/2 lb ai/A	Hardwoods and conifers by injection	Long	May damage untreated conifers ("flash-back"); Tordon 101R contains half the picloram of Tordon 101	Cut Surface	$10/gal for Tordon 101R and $17.50/gal. for Tordon 101

Table 31 (Continued)

Herbicide	Formulation	Season of Application	Carrier and Volume	Application Rate	Selectivity	Relative Persistence	Use Precautions	Route of uptake	Cost ($/lb or $/gal)
Picloram (cont)	Trilsopropanolamine salts of picloram & 2,4-D (Tordon 101) with or without low volatile esters of silvex.	Spring to mid-summer	10 to 25 gal. per acre in water	1 to 4 gal/A 2-1/2 to 10 lbs ai/A	Shrubs and weed trees for site preparation	Long	Must use application methods that reduce drift.	Foliage	$17.50/gal.
Dicamba	Dimethylamine salt	all	Water or undiluted	Undiluted or 1:4 in water. 4 lb ai/A	Hardwoods and conifers by injection	Moderate	LD50-1040 mg/kg	Cut surface	$34/gal.
	Dimethylamine salts of dicamba and 2,4-D	Spring to mid-summer	16 to 300 gal/A in water	1 to 3 gal/A 1-3 lbs ai/A	Shrubs and weed trees for site preparation	Moderate	Not as effective as picloram or as oil soluble formulation	Foliage	$13-$18/gal.
	Oil-soluble acid of dicamba + isoacytle esters of 2,4-D	Dormant (fall to late winter)	30 gal/A in diesel	1 gal/A 4 lbs ai/A	Shrubs and weed trees for site preparation	Moderate	More effective than water-soluable formulation	Stem	$17-$20/gal.
Dalapon	74% sodium and magnesium salts-water soluble	Late winter to early spring after grasses emerge	5 to 10 gal/A areal; 10 to 100 gal/A ground in water	3 to 11 lb ai/A	Annual and perenial grasses for site preparation use with atrazine or directed sprays for release	Short	Use 1/2 to 4 pints surfactant per 100 gal; delay planting 2 weeks if rate over 8 lb.; apply when grasses are actively growing; LD50-6500 mg/kg	Foliage & root	$1.96/lb.
Atrazine	80% wettable powder	Late winter	10 gal/A in water	3 to 4 lb ai/A	Annual grasses and some forbs; does not damage conifers when properly applied	Short	Requires at least 2 inches of rain after application; LD50-3080 mg/kg	Root	$2.80/lb

Table 31 (Concluded)

Herbicide	Formulation	Season of Application	Carrier and Volume	Application Rate	Selectivity	Relative Persistence	Use Precautions	Route of uptake	Cost ($/lb or $/gal)
Krenite AECP (Ammonium ethyl carbamoylphosphonate)	Krenite-water soluble liquid	Late summer to early fall	10-40 gal/A aerial; 50-300 gal/A ground in water	1-1/2 to 3 gal/A 6 to 12 lbs ai/A	Deciduous species for site preparation	Short	Applied in 2 month period before fall leaf coloration; LD50-24,000 mg/kg	Foliage	$32/gal
Simazine	Crystalline solid, having a solubility in water of about 5 ppm	Late winter & spring	20 gal/A in water	2 to 4 ai/A	Broadleaf and grass weeds for site preparation	Moderate	Requires up to 3 or 4 inches of rain after application	Roots	$17.75/gal.
Roundup	Water soluble	spring, fall	10 gal/A in water	1 qt. to 1 gal.	Deciduous trees, shrubs, weeds	Short	Apply only to undisturbed areas	Roots	$50-$60/gal.

Short = 1/2 life 4 months; moderate = 1/2 life 5-8 months; long = 1/2 life 8-12 months.
ae = acid equivalent; ai = active ingredient.
Season of application may vary depending upon local conditions.

These generalizations about successional changes produced by herbicides are broadly true across different sub-biomes. Yet within sub-biomes, different competition regimes exist and different herbicides are targeted against different species. Approximately 50% of BLM land should require no treatment at all. (Gratkowski, personal communication). Since severity of competition varies, the extent of seral acceleration possible with herbicide treatments also varies.

Succession proceeds at varying rates within each sub-biome, depending on variation in soil, aspect, and other factors. It is neither practical nor necessary to exactly quantify successional changes produced in any particular year through the use of herbicides. The commercial forest does not represent a steady state with a balance of naturally established plant communities. Logging continues to create new early seral vegetation. Without herbicide treatments the percentage of BLM commercial land occupied by grass or brush to the exclusion of conifers would increase unless logging was also stopped or drastically reduced.

Systematic surveys produce one-time estimates of acreages requiring herbicide treatment if some particular management objective is to be met. For instance, a recent survey concluded that more than 100,000 acres of brush and 3/4 million acres of brush-hardwood mixtures -- almost all convertible to conifers of commercial value -- presently occur on 6.1 million acres examined in Washington and Oregon (Dimock, et. al., 1976). These brushlands are similar to some of those proposed for treatment with 2,4-D, Silvex, Krenite, Roundup, and Tordon as described in Chapter I.

Since the various proposed uses of herbicides have different effects on vegetation, specific effects are presented separately for each use. The impact of specific herbicides on specific plants is well documented in most cases. However, Krenite and Roundup described for use in the proposed action are relatively new to forestry.

Site Preparation

As described in Chapter I, the application of atrazine, dalapon, 2,4-D, silvex and krenite on 25,876 acres in 1978 is for site preparation purposes. Tordon K and Verton 2 D, used in brown and burn operations, are also used for site preparation. The poundage and specific treatment acreage of each chemical proposed for use is given in table 1 (Chapter I). The role of these specific chemicals is to limit plant competition, thereby aiding in reforestation.

The role of vegetation management in reforestation was recently summarized (Cleary, 1978). During the establishment period for young conifers, water use by grass and brush most frequently causes the death or slow growth of seedlings. Secondary causes of mortality and lost growth include a lack of sugar production (caused by low light intensity under brush), mechanical injury or animal damage arising from habitat furnished by brush.

In site preparation, herbicides may be targeted against either native or introduced plants or both. In the Willamette Valley forests, introduced plants compose about 50 per cent of the herbaceous species and 90 per cent of

the grass encountered in early seral communities (Newton, personal communication). The invasion of sites by new competitors can result in substantial changes in forest succession (Spurr, 1964). When targeted against introduced competitors, herbicides have the effect of moving plant communities toward higher successional stages dominated by native species, such as conifers.

In site preparation, grass may be controlled for one to three years with atrazine and dalapon, while conifer seedlings establish themselves. Grass may then partially re-occupy the site until conifer crown closure shades it out. Most species of brush such as vine maple re-sprout after treatment with 2,4 D or silvex. After site preparation sprays and tree planting, brush may again dominate the site unless followed up with a release spray. Successive treatments are needed to control some brush species, depending on the degree of control desired (Gratkowski, 1968). Poor results have been achieved with spray techniques alone in reforesting multi-stories coastal brush fields in the Northwest Coastal sub-biome. Combinations of chemicals and fire, as in brown and burn operations, are particularly effective in these instances (Dimock, et. al., 1976). The development of new herbicides like "Roundup" may also prove effective on understory shrubs.

The effect of vegetation control on survival and growth of planted trees is well documented as described in the following paragraphs. On many sites successful reforestation clearly requires more than just planting trees.

In a study of the 10-year history of an Oregon coastal plantation, annual mortality of conifer seedlings was consistently greater in heavy shade beneath shrubs (Ruth, 1957). A conifer plantation consists of survivors, and chemical weed control can increase the percentage of surviving trees on reforestation project areas (Newton, 1967).

The application of atrazine and dalapon is an effective method of controling grass competiton. Atrazine is valuable against annual grasses, while dalapon broadens the spectrum of control to include perennial grasses. In a study by Bichtord and Hermann (1967), application of 5 pounds of atrazine per acre as described in the proposed action increased first year survival of Douglas-fir for the treated area 5 times over the survival on the untreated.

In 1964, BLM concluded that on foothill sites occupied by grassy vegetation, 85 per cent of the summer moisture loss was due to herbaceous vegetation transpiration alone. Reduction of the herb cover with herbicides reduced moisture loss to only 15 per cent of that on fully vegetated sites. Survival of planted seedlings improved from plantation failure to survival of 60-95 per cent with great improvement in vigor and rate of development in the following season (Information Memo No. Oreg-Wash 64-49).

Lack of vegetation control frustrates other measures taken to help insure seedling survival. In 1977, the Roseburg district of BLM concluded from field trials that shading of planted seedlings did not help much if site preparation sprays were needed and not used (Forestation Notes No.

48). On dry, hot sites, vegetation provides shade resulting in a milder microclimate for seedlings. This is offset by the moisture demands of the competing vegetation unless the vegetation is topkilled (Cleary, 1978) (Cleary, 1970) (Tarrant, 1957).

Gratkowski (1975) pointed out that for site preparation more complete control is needed than for release. A high percentage of competitive plants must be killed and there must be a minimum of resprouting. The phenoxy herbicides such as 2,4-D and Silvex are active against both deciduous and evergreen hardwoods. Krenite and Roundup are active against deciduous brush only, but roundup is also active against a broad spectrum of herbaceous species.

Release

As described in Chapter I, brush control chemicals -- 2,4 D, silvex, tordon, Krenite, and Verton -- are targeted against brush or hardwood species which effectively limit crop tree growth. Atrazine and dalapon may sometimes be used for release from dense grass. Release of conifer, including control of hardwoods in thinnings, is the purpose of herbicide application 1978 on 45,815 acres. In release operations, the silvicultural objective is not necessarily to kill all competitive vegetation but to increase the amount of light reaching young conifers in the understory and to decrease brush competition for soil moisture and nutrients. The proposed action is directed at obtaining a high percentage of defoliation, a fair amount of tophill and a minimum of resprouting. Reduction in the growth of competing vegetation for 3 to 5 years is

usually sufficient (Gratkowski, 1975). Resprays may be needed to accomplish this control, especially if less effective herbicides are used (Gratkowski, 1968).

The evidence that brush control speeds conifer growth is quite extensive. Ceanothus species, especially varnishleaf, deerbrush, and snowbrush are targets of the proposed action. A dense overstory of varnishleaf ceanothus can reach a height of 25 feet and severely retard height growth of conifer seedlings. In a study in western Oregon, selective herbicides were used to release Douglas-fir from varnishleaf competition and growth of released and unreleased Douglas-fir was measured for five years after treatment. Height growth of released trees was 29 to 86 per cent greater than height growth of unreleased trees under live ceanothus (Gratkowski, 1967). Height growth of Douglas-fir released from vinemaple and other species of brush in western Oregon was 61 to 178 per cent greater than that of stock not released. In all cases, diameter growth increase was comparable to height growth (Lauterbach, 1967).

A long-term study to compare the growth and development of red alder and conifer stands was started on the Cascade Head Experimental Forest in 1935. Study plots were established on abandoned cleared land where 8 to 12-year-old stands of mixed red alder and conifers were developing. Initial treatment resulted in a number of experimental stand compositions, including a pure conifer stand where all of the red alder trees were cut down; and a mixed alder-conifer stand that was left untreated. At 30 years of age the pure conifer stand hand responded well to release, while the prolonged competition between species in the mixed stands resulted in a reduced growth.

Bently (1967) found that height growth of ponderosa pine was dependent on the volume of brush occupying a site. With less brush, height growth of pine increased. The injection of non-commercial hardwoods with herbicides during thinning treatments of conifer stands is one method of releasing conifers from residual hardwoods. In studying actions similar to the proposed cut surface (stump) treatments with tordon, Rodosevick, Passot, and Leonard (1976) reported that cut surface treatment of tanoaks and madrone released Douglas-fir with resulting diameter growth gains of 260 to 405 percent over no treatment after 10 years.

Control of Noxious Plants

Some of the plant species on BLM land are noxious or poisonous to cattle (such as Tansy ragwort). Control of these plants in recreation sites, in fields, or along roadsides by spot treatment with 2,4-D as in the proposed action is highly selective and is designed to kill only the target plants actually sprayed.

Maintenance of Improvements

Along roads or around buildings, vegetation may be excluded or limited by various combinations of herbicides. Desirable conifers that have invaded a site may be injured or killed.

Vegetation control around buildings or along roads may be maintained as long as needed, but retreatment is necessary to attain continued control. In the proposed action non-selective chemicals such as dicamba or diuron are often used. Most species of vegetation are killed or controlled. The use of 2,4-D and Silvex will effect only brush species, leaving grass along roads.

Other Potential Effects

Improper herbicide application may result in damage to conifer stands. Minor burning of needles by oil carriers occurs. Destruction of understory or intertwined conifers by falling dead brush, especially snowbrush ceanothus or red alder, is also possible.

Herbicide application may result in species compositional and structural changes in the resultant forest. Foliar active chemicals such as dalapon or the phenoxy herbicides can kill or damage exposed pines (Gratkowski, 1961, 1975). Similar effects have been observed on Incense Cedar. In the mixed conifer and mixed evergreen zones of the Montane Coniferous Forest sub-biome, brush control activities may result in the intentional removal of major hardwood components of the unmanaged forest. Through the use of herbicides in an even-aged management scheme, forests are produced with relatively even-aged stand structures on land previously occupied by uneven-aged or multiple storied structures.

Non-target vegetation such as agricultural crops immediately adjacent to spray units may be effected by the movement of herbicides through the air, water, or soil. Such movements are limited but not eliminated entirely by buffer strips and by application techniques (Gratkowski, 1974). The possibility of vegetation impacts from accidental spills always exist. Non-target herbaceous plants on spray units may be killed or damaged by chemicals targeted on certain other competitor species. Non-target conifers may be killed by cut-surface treatment of hardwoods with picloram by translocation through root systems, but not with the phenoxy herbicides (Radosevich, et. al.). The spectrum of control with herbicides is manipulated by changing the chemical itself, the carrier and the season of application. Relatively broad spectrum herbicide combinations, such as a tank mix of atrazine, dalapon, and 2,4-D have the greatest chance of damaging non-target plants on the spray site. Existing drift control technology is effective in limiting the drift of herbicides off the spray site (Stewart and Gratkowski, 1976). Oil carriers tend to result in more drift than oil-in-water emulsions.

2,4-D has been shown to have some mutagenic potential with some agricultural plants, but no specific effects are known for silvex (Moah, 1969). Atrazine was shown to have a slight effect on meiosis when applied to the anthers of barley (Report on the Secretary's Commission on Pesticides). No conclusive evidence of plant mutations was found by Andersen (1972) for either dicamba or dalapon. The occurrence or significance of mutations arising in nature from the use of these compounds is unknown. Fasciation, the deformation of tissue in branches and stems in plants, occurs in nature in both sprayed

and unsprayed areas. Fasciation is expressed erradically and has various causes both genetic and non-genetic (Kim Ching, personal communication). It is not observed to be a frequent or significant result of herbicide use.

Persistance in Vegetation

The persistence of applied chemicals in vegetation varies widely. Growth dilution, weathering, and metabolism of the herbicide by the plant cause a rapid decrease in concentration. Herbicide residues are not the same in all plant species however (Norris, 1965). The phenoxy herbicides are fairly rapidly degraded, but picloram degrades more slowly. Dalapon is neither metabolized nor broken down by either susceptable or resistant plants, but remains in plant tissue as dalapon (Leasure, 1963).

Little specific research information on residues of silvex in a forest environment is available. However, silvex itself is less toxic than 2,4,5-T. Both are closely related compounds and both contain the contaminant TCDD. The behavior in the environment and the risk of human exposure for silvex would be expected to be similar to 2,4,5-T.

Norris (1976a) has discussed behavior and impact of 2,4,5-T in the forest. Norris points out:

> The resprouting of lush, succulent vegetation on many spray areas within a year after application is evidence

> of this fact. Residues of more than a few parts per million of herbicide would produce visible damage symptoms and/or prevent such resprouting. We conclude, therefore, that resides of this magnitude do not occur in this vegetation.

Norris et al. (1977) examined samples of blackberries, vine maple, Douglas-fir, grass, forest floor, and soil "for 2,4,5-T immediately after and 1,3,6 and 12 months after aerial application of 2,4,5-T isooctyl ester at 2 lb/A. This sampling regime was repeated after a second application 12 months later." The authors found:

> Initial concentrations of 2,4,5-T varied among plant species from 11 ppmw in vine maple to 115 ppmw in grass. After 1 month, concentrations ranged from 0.5 to 11 ppmw; and after 1 year, maximum residues were less than 0.5 ppmw. Residues in understory vegetation were higher after the second application probably because of the reduction in overstory vegetation after the first application. Herbicide residues were not detected in samples collected 1 year later.

Morton et al. (1967) found the half life of 2,4-D to be between two to three weeks on forage grasses when applied at the rate of one pound per acre. Norris and Freed (1966a, 1966b) applied three formulations of

2,4-D to bigleaf maple under laboratory conditions. Of the material absorbed, most remained in treated leaves. New growth, the stem, and roots contained translocated material in decreasing amounts in the order given. Differences between formulations were not significant, but differences in the amounts recovered from various sites in the plant may account for differential effects on plant foliage, stems, and roots. The amount of 2,4-D absorbed by the plant varied, but order of sites in which decreasing amounts of 2,4-D occurred was the same. Any residues not absorbed by the plant may be washed off by rain or fall to the forest floor when the leaf falls from the plant.

Residues of picloram in woody plants in tropical areas ranged from 31 to 687 ppm immediately after spraying two pounds of active ingredient per acre. This dropped to less than one ppm a month later (Bove and Scrifres, 1971).

The Dioxin, TCDD found in Silvex is not translocated by plants from the point of application to other parts of the plant. Some is washed off by rain water (Kearney 1973, Isensee and Jones 1971). Only trace amounts of TCDD are taken up by plants after exposure to levels of TCDD containing 40,000 times the concentration expected from the application of brush control chemicals (Ischirley 1971, Isensee and Jones, 1971). The levels of TCDD encountered in normal field application of silvex is not known to impact vegetation in any way. TCDD on leaves is lost by photo-degradation in a single day (Crosby and Wong, 1977).

The use of foliar sprays on brush may increase the danger of fire. Areas prepared for brown and burn operations present the worst hazard if not burned according to plan. Some 957 acres are proposed for treatment in 1978. Standing dead brush presents less of a hazard than cut brush. Pre-emmergent grass control sprays with atrazine probably reduce fire hazard since the quantity of fuel on a site is less.

BLM has made a tentative inventory of rare and endangered plants which exist on its land. The inventory is considered incomplete at this time. There is the possibility that some of these plants will be inadvertently treated with herbicides depending on their stage of development and position in the vegetative community in relation to the target species.

Since the severity of competition varies from stand to stand and from site to site, the benefits derived from herbicide use also vary. Herbicides improperly applied or used to control plants which are not actually competitors are ineffective and costly.

Impacts on the Timber Resource

The impact of the proposed site preparation with herbicides will be the rapid establishment of the number of commercially valuable conifers required per acre for high levels of timber production. On areas proposed for release treatments, conifers will be released from competing brush and grow at rates approaching the capabilities of the site. The time required to establish fast

growing stands of young conifers after the removal of mature timber is shortened and the number of conifers per acre is increased through the effective management of competing vegetation by any method.

Non-commercial hardwoods will be killed on 90 acres of thinned conifer stands, Tansey ragwort will be eliminated from 200 acres and roadside vegetation will be controlled on 2,545 acres. On all acres except the 2,545 acres of roadside treatment and 957 acres of brown and burn treatment, only the target vegetation will be controlled. Effects on other vegetation will be minor. The 957 acres of brown and burn will be promptly restocked with conifers, but the 2545 acres of roadside maintenance will be intentionally kept largely free of brushy vegetation.

Cumulative Impacts

The actual activity of the chemicals proposed for use will be relatively short-term (see table 31). The effect of successfully establishing a conifer stand is relatively long-term and is the same for each sub-biome. Conifers will occupy the site until removed by fire, disease, insects, or logging. Repeat sprays may be necessary to maintain conifer dominance early in the life of a plantation. It may be necessary to repeat atrazine and dalapon sprays for 2 seasons after planting to insure conifer survival. Grass will re-invade sprayed sites within one year after atrazine application. Brush generally recovers from application of 2,4-D, Krenite or silvex within 3 to 5 years. The response to Roundup is different in that the chemical is translocated to

the roots and the brush does not resprout. However, Roundup gives only poor control of some deciduous species such as alder and big leaf maple, and no control of evergreen brush.

Despite the possible need to re-treat, there are no cumulative impacts to vegetation that are other than the additive effects of increased conifer growth. Resprouting brush may show minor growth deformations. Shrubs resprouting after initial sprays are much easier to kill with follow-up sprays than are full-crowned mature plants (Gratkowski, 1968). Three sprays will generally be the maximum any acre receives.

BLM proposes to spray approximately 745,000 acres over the next 10 years. Of this, possibly 50% will be retreatments of earlier sprayed acres.

Conclusions

The commercial forest does not represent a steady state. Logging continues to create new early seral vegetation. Without herbicide treatment, the percentage of BLM commercial forest land occupied by grass or brush would increase. The proposed action will have the following specific impacts:

1. Relative species abundance, size, density, and vigor will be altered on all acres treated. Conifers, such as Douglas fir, will generally be favored.

2. In forestry use, plant succession will be accelerated. Conifers will be established and will grow at rates determined by the basic site productivity rather than at rates determined by vegetation competing with conifers. Generally, plants will not be eliminated as a direct result of spraying, but may die out of the treated units as vegetative succession proceeds.

3. In roadside or maintenance of improvement sprays, all or most vegetation will be eliminated. Grass along roadsides may be intentionally left when control is aimed at brush invading right-of-ways. Reinvasion of the sites by vegetation will occur unless control efforts continue.

4. Non-target plants that exist on or near spray areas may be killed or damaged. This may include plants on the tentative rare and endangered species list.

5. Non-target agricultural crops or ornamental vegetation adjacent to treatment areas may be killed or damaged. However, untreated buffer strips and application techniques can be employed to reduce this hazard.

TERRESTRIAL WILDLIFE

The proposed action calls for use of herbicides on 74,436 acres in 1978 and a similar amount annually for the next ten years throughout the various sub-biomes as discussed in Chapter II. All of the areas proposed for treatment provide habitat for certain forms of wildlife. Wildlife species commonly associated with the various sub-biomes and successional stages are illustrated in Chapter II.

Herbicide treatment as proposed for forestry use may alter wildlife habitat with impacts being both beneficial and detrimental. The magnitude of these impacts are analyzed in following discussions.

The magnitude of the impact of the proposed herbicide program on plant community structure, diversity, and succession as it related to associated wildlife can only be projected in relatively general terms. In western Oregon the Bureau manages approximately 1.9 million acres for timber production. Approximately one-eighth or 250,000 acres of this forest land will consist of newly harvested areas or coniferous plantations in the 1- to 10 year age class at any one point in time as a consequence of timber production goals. These areas will contain vegetation in the early seral stages; grass-forb, shrub-sapling in addition to conifers. As proposed, the annual herbicide program is projected to treat 74,436 acres. This acreage represents 28 percent of the total acreage in the early (1 to 10 year) seral stages. However, because at least 50 percent of the proposed treatment areas are actually retreatments,

the percent of the total acreage in the early seral stages (1-10 years) subjected to herbicides at any point in time may be in the range of 10-14 percent.

Kinds of Impacts

The impacts of herbicides on wildlife are expected to vary depending on the specific herbicides used to treat the different vegetative species.

Generally, there are two major avenues for wildlife to be impacted by herbicides used in forestry, (1) exposure of these animals to toxic levels of herbicides and (2) through habitat modifications.

Toxicity Impacts

None of the herbicides proposed for use in western Oregon forest applications have been reported to be highly toxic to wildlife, when used as manufacturers label prescribes (reference table 32). Table 7 in Chapter I includes a list of herbicides scheduled for use and the target vegetation. In the following analysis of the impacts of chemicals on wildlife, by various researchers, where it is not specifically identified it has been assumed that the research cited is relevant to the proposed action.

The general toxicity of a herbicide on animals depends on the individual organisms resistance and the amount of exposure to the herbicide treatment.

Kimmins (1975) reports that most terrestrial organisms usually show greater tolerance to herbicides than most aquatic organisms. He also states that terrestrial organisms tend to eliminate herbicides rapidly.

Many researchers have reported that wildlife are bound to ingest (non-toxic doses) of herbicides by consuming contaminated food or water immediately post treatment. Several factors make it highly improbable for an animal in the wild to receive a toxic dose of herbicides. The factors being that an animal would not normally be able to ingest sufficient quantities of treated forage and that during application volization occurs resulting in a reduced amount of the herbicide actually reaching target vegetation. Also, once a plant has absorbed a chemical metabolic processes begin to break down the compound.

Studies have shown than an animal is unlikely to ingest toxic levels of herbicides from treated forage (Rudd and Genelly 1956; Springer, 1957; Mellanby, 1967; Montgomery and Norris 1970; and Norris, 1971.) Springer, 1957 found that test animals are often repelled by herbicide residues on their natural foods, and will not eat freshly treated vegetation if other food sources are available.

It is highly improbable that all vegetation a treated area would be contaminated by spray, therefore it is logical to conclude that it is unlikely that browsing animals would consume only plants with herbicide residue. The mechanical and environmental factors previously mentioned support this conclusion.

The above mentioned evidence indicates that many animals will tend to avoid foraging on vegetation contaminated with herbicides. However, Newton and Norris (1968) found that in western Oregon black tailed deer remained in the treated area and fed. These researchers found that deer feeding on treated vegetation did not accumulate significant amounts of herbicide, even when exposed to maximum field application rates of 2,4-D, and atrazine. Residues were found to be less than 0.006 ppm in the muscle tissue of deer 43 days after exposure. Atrazine residue could not be detected after 44 days. It must be recognized that Newton and Norris (1968 data) is not conclusive, but it does support the theory that ruminants are able to degrade herbicides and little bioaccumulation occurs. EPA 1964 data supports the conclusion of no apparent bioconcentration.

Much of the general toxicity attributed to 2,4,5-TP (Silvex) appears to have been caused by the contaminant TCDD (dioxin). Calculations indicate that the levels of TCDD which might occur in the environment from the use of Silvex are far below those which cause a harmful effect on living organisms. However, a general data gap exists on the effects of field use of using herbicides containing TCDD and the impact of residues on wild animals. EPA conducted a study on 2,4,5-T treated National Forest lands in 1973 to determine if TCDD levels existed in wildlife. The results indicated TCDD in minute quantities (parts per trillion) in a small percentage of the samples (Exhibit 8, U.S.F.S Environmental Statement, Vegetation Management with Herbicides, 1978). More detailed information on the results of studies of TCDD and animals is found in the discussion of human health presented in the latter part of this chapter.

Roundup as used in manufacturers formulations was found to be non-toxic to mammals in oral ingestion tests (Monsanto, 1977).

In western Oregon, Borreco found that small mammals such as Oregon vole deer mouse, Pacific jumping mouse, vagrant and Trouebridge shrews, exhibited no toxic responses to herbicides in his forest land study.

Fears of toxicity to animals appear to be without basis when the herbicides proposed in this program are used at manufacturer's recommended rates (Brown 1967; Norris 1971).

Feeding studies on various animals by researchers reveal that herbicides are rapidly excreated with body wastes.

The toxicity to mammals of various herbicides proposed for use in this program are illustrated on table 32. The LD_{50} values in table 32 are expressed as the mg. of pesticide per kg. of body weight which will kill 50 percent of the test animals when given in a single oral dose. LD_{50} is considered a measure of acute toxicity.

Representatives of mammalian orders listed in table 32 are related to similar groupings of animals that could be found in the proposed treatment areas (i.e. dog - coyote). Therefore, the toxicological data describing these chemicals are expected to be similar for field species if studied under laboratory conditions. Field application rates of herbicides never reach LD_{50} dosage levels.

TABLE 32

TOXICITY OF MAMMALS TO VARIOUS HERBICIDES

	Chemical	Oral Dose	LD 50	Source
Rat	Silvex		30 mg/kg	House, et al., 1967
Rat	Dicamba		2,900 mg/kg	Pimentel, 1971
Rat	Krenite		24,400 mg/kg	USDA, 1976
Rat	Duiron		3,400 mg/kg	USDI, 1973
Mammal	2,4-D	(yes)	375-700 mg/kg	W.H., and Baumgartner 1973
Rat	2,4-D	(yes)	666 mg/kg	Spector, 1955
Mouse	2,4-D	(yes)	375 mg/kg	Spector, 1955
Rabbit	2,4-D	(yes)	800 mg/kg	Spector, 1955
Dog	2,4-D	(yes)	100 mg/kg	Spector, 1955
Guinea pig	2,4-D	(yes)	1,000 mg/kg	Spector, 1955
Mule deer	2,4-D	(yes)	400-800 mg/kg	Witt & Baumgartner 1973
Mammals	Dicamba			
	(acid)	(yes)	2,100-3,700 mg/kg	Witt & Baumgartner 1973
	(salt)	(yes)	566-1,028 mg/kg	Witt & Baumgartner 1973
Mammals	Silvex	(yes)	650 mg/kg	Witt & Baumgartner 1973
Mammals	Picloram	(yes)	2,000-82,000 mk/kg	Witt & Baumgartner 1973
Mammals	Atrazine	(yes)	1,750-3,800 mg/kg	Witt & Baumgartner 1973
Rat	Roundup	(yes)	4320-5400 mg/kg	Monsanto, 1977
Rabbits	Roundup	(yes)	3800 mg/kg	Monsanto, 1977

Pimentel, 1971, and Witt and Baumgartner, 1973, report that Dicamba presents no hazard to man and has low toxicity to wildlife. The EPA, 1974 reports that Dalpon has a short residual life and has low mammalian toxicity. The agency also reports that simazine has low toxicity to mammals, however, it does have some residual life.

A direct effect of herbicides on vegetation being consumed by wildlife is that chemical alterations can occur. There are two chief concerns; the possible impact that phenoxy herbicides may render toxic plants normally not eaten, palatable and the reverse, rendering normally acceptable plants toxic. These possible impacts are not well documented and to what extent this action occurs is unknown. There are no reports of this effect on wildlife (Rudd & Genelly) (George 1963). Plant metabolism may reduce the possibility of this change happening.

The toxicity of herbicides to birds is summarized by Hill et al, etc., (1975). See table 33 for the LD50 of herbicides on birds. The LD_{50}'s (lethal concentration) values in table 33 are expressed as ppm of pesticide in diets of test animals which will kill 50 percent of animals tested. Here again, representatives of genera tested are similar to some which are expected to be found in the proposed treatment areas, such as the blue grouse.

Generally, herbicides have been found to be less toxic to birds than other pesticides: Most acute toxicity LD_{50}'s to birds tested were greater than 5,000 ppm. However, literature on the sub-lethal effects of herbicides on birds is limited.

Table 33

Dietary toxicities of Herbicides tested in 5-day diets of young bobwhites, Japanese quail, ring-necked pheasants, or mallards (1964-1973) Fish and Wildlife Service - Wildlife Report No. 191

Compound Species	Age (days)[a]	No. of conc.[b]	No. birds conc.	Toxicity Statistics LC50[c]	(95% C.L.)	Slope[d]	(S.D.)	RTD[e]	(95% C.L.)
Dalapon, sodium salt									
Japanese quail	12	3	14	>5000	(No mortality to 5000 ppm)				
Ring-necked pheasant	10	3	8	>5000	(No mortality to 5000 ppm)				
Mallard	10	3	10	>5000	(No mortality to 5000 ppm)				
Diuron									
Bobwhite	9	5	10	1730	(1482-2035)	7.218	(1.796)	41.4	(33.8- 5)
Japanese quail	12	3	14	>5000	(No mortality to 1250 ppm, 14% at 5000 ppm)				
Ring-necked pheasant	15	6	9	>5000	(No mortality to 1500 ppm, 11% at 2000 ppm, 33% at 4200 ppm)				
Mallard	10	6	10	app.5000	—			app.28.6	
Atrazine									
Bobwhite	9	3	10	>5000	(No mortality to 5000 ppm)				
Japanese quail	7	3	10	>5000	(No mortality to 25oo ppm, 7% at 5000 ppm)				
Ring-necked pheasant	10	3	8	>5000	(No mortality to 5000 ppm)				
Mallard	10	3	10	>5000	(No mortality to 2500 ppm, 30% at 5000 ppm)				
2,4-DB									
Bobwhite	14	3	10	>5000	(10% mortality at 2236 ppm, 40% at 5000 ppm)				
Japanese quail	14	3	12	>5000	(No mortality to 5000 ppm)				
Ring-necked pheasant	14	3	10	>5000	(No mortality to 5000 ppm)				
Mallard	10	1	10	>5000	(No mortality to 5000 ppm)				

Table 33 (concluded)

Dietary toxicities of Herbicides tested in 5-day diets of young bobwhites, Japanese quail, ring-necked pheasants, or mallards (1964-1973) Fish and Wildlife Service - Wildlife Report No. 191

Compound / Species	Age (days)[a]	No. of conc.[b]	No. birds conc.	Toxicity Statistics LC50[c]	(95% C.L.)	Slope[d]	(S.D.)	RTD[e]	(95% C.L.)
Diuron									
Bobwhite	9	5	10	1730	(1482-2035)	7.218	(1.796)	41.4	(33.8- 5)
Silvex									
Japanese quail	12	3	14	5000	(No mortality to 5000 ppm)				
Ring-necked pheasant	10	3	8	4500	—			96	—
Silvex, butoxyethanol ester									
Bobwhite	14	3	10	3031	(2441-3774)	10.808	(3.945)	113	(84.2- 1)
Japanese quail	14	3	16	5000	(No mortality at 1250 ppm, 6% at 2500 ppm, 12% at 5000 ppm)				
Ring-necked pheasant	10	3	8	2100	—			app.44.7	—
Simazine									
Bobwhite	10	3	10	5000	(No mortality to 5000 ppm)				
Japanese quail	12	3	14	3620	(No mortality to 3720 ppm)				
Ring-necked pheasant	10	3	8	5000	(No mortality to 5000 ppm)				
Mallard	10	3	9	5000	(No mortality to 5000 ppm)				
2,4-D, dimethylamine salt									
Bobwhite	23	2	7	5000	(No mortality to 5000 ppm)				
Japanese quail	20	4	20	5000	(No mortality to 5000 ppm)				
Ring-necked pheasant	10	3	8	5000	(No mortality to 5000 ppm)				
Mallard	17	3	8	5000	(No mortality to 5000 ppm)				

The acute oral toxicity of 2,4-D fed daily to chicks for 28 days was found to be low (T. Schirley, 1970).

Kopischke (1972 reported that spraying of pheasant eggs with 2,4-D at concentration comparable to those of a normal field herbicide treatment did not affect hatchability of eggs or cause death or deformity in hatched chicks. It is reasonable to anticipate that results can be related to the comparable birds of the forest.

The LD_{50} for Krenite for mallard ducks and bobwhite quail is greater than 10,000 mg/kg.

The LD_{50} toxicity of dicamba is set at 673 mg/kg for domestic hens and 800 mg/kg for pheasants (Velsicol Chemical Corporation, 1974).

Dalapon is relatively non-toxic to quail, pheasants and ducks. However dalapon appeared to depress reproduction of ducks when they were fed levels of less than 25 percent of that formulation which produced mortality.

The LD_{50} for Roundup in eight day dietary study on Bobwhite Quail and mallard ducklings is estimated to be greater than 4640 ppm for both species (Monsanto, 1977).

Beaver 1976, found that birds in herbicide treated areas shifted their diets and used alternative food sources. This factor may have been due to the loss of food plants rather than its contamination.

Tordon presents "no hazard what-so-ever to birds" (Kenaga, 1969).

DIESEL OIL

Diesel oil is often used as a herbicide carrier. With the exceptions of fish and ducks, the effects of diesel oil on wildlife have not been examined. Data on the toxicity of diesel oil on wildlife is limited. Oral toxicity data for ducks suggest that diesel oil has a low toxicity.

A few studies have been conducted on the adverse effects of diesel oil on ducks. The acute oral LD_{50} to male and female mallards, greater than 12 months in age, is given as greater than 20 ml/kg (Tucker and Crabtree, 1970). In this study none of the animals died at the highest dosage given (20 ml/kg). This acute oral LD_{50} for healthy white ducks was found to be greater than 24 m/kg (Hartung, 1966). This quantity is far higher than a duck would consume with foliage sprayed during a normal forest application of herbicide. A bird may also ingest some diesel oil by preening itself after being exposed to aerial spray. It was found that a duck ingested through preening about 1/3 of the oil sprayed on its feathers (Hartung, 1965).

The use of heavy amounts of diesel oil could possibly adversely affect the hatchability of eggs that are sprayed. An oil coating on the eggs will block gas exchange through the shell and the embryo will die. In one study 57 viable pheasant eggs were sprayed with diesel oil to runoff, none of the eggs hatched (Kopischke, 1972).

This is a far larger amount of spray than the eggs would receive in a normal forest application. In another study fertile chicken eggs were sprayed with diesel oil at the rate of 10 gallons per acre, none of the eggs hatched. Further studies showed that just coating the large end of the egg with diesel oil was adequate to kill the embryo (Kieth, 1964). Because the dormant sprays, using mostly diesel oil as the carrier, are applied early in the year, they are not expected to interfere with the nesting suceess of oviparous wildlife species. (For possible exceptions see table 34.) Diesel oil used in combination with water or singly is proposed for use as a herbicide carrier on 42,206 acres in 1978. The chances of wildlife (mainly birds, amphibians and reptiles) of becoming sufficiently coated with spray to cause bodily harm is remote. Most birds place nests in sheltered areas to protect them from predators. Also, if birds nests are aborted early in the reproductive period, most species will renest. Of the forest animals, birds may be the most susceptible to the impact of oil used as a herbicide carrier. Any bird accidentally receiving a complete soaking during a herbicide application could lose the ability to fly. Loss of flight capabilities subjects the bird to predatory animals. A secondary, but important impact of oil on bird feathers, is the loss of structure caused by matting. Birds which flush or

fly directly below or or airplane may receive a complete wetting of spray. Matted feathers provide no insulation characteristic, thus a bird can become susceptable to hypothermia, or rapid heat loss. Early spring applications of herbicides are the most critical to birds, because of coinciding cool weather. Table 34 illustrates the possible overlap periods between herbicide application scheduling and avion reproductive seasons. A combination of factors reduces the possibility of flushed birds from being contaminated with oil, these include; the small amount of oil carrier used per acre, the volitilization of a portion of the sprays and the natural feature of overhanging vegetation intercepting most herbicide. Also, birds are mobile and may flush prior to the arrival of the treatment aircraft, due to the noise factor.

Some adverse impacts to wildlife may occur where spray lanes overlap and double treatments result or where helicopter flight requirements (height and speed) are not maintained. The effect of herbicides on native insect populations has not been studied; however, the effect of 2,4-D on bees has been studied by a number of workers. When 2,4-D dust was applied directly to bees and to the crawl space at hive entrances, neither the adult bees nor the brood were adversely affected (Palmer-Jones, 1964). Brydy reported total mortality of bees within 4 days of feeding with 30 micrograms of 2,4-D and 10 per cent mortality within 3 days with 20 micrograms (Brydy, 1962). Johansen (1965) reported that 2,4-D and related compounds were not toxic to bees, except when formulated as alkanolamine salt or the isopropyl ester.

Table 34

Relationship of Proposed Herbicide Application
Periods to Peak Avian Reproductive Seasons

Herbicide	General Chemical Application Period		Season of Occurrence	Reproductive
Silvex	Feb-Sept	Osprey	Feb-October	April-July
Silvex + 2,4-D	Mar-Oct	Poorwill	April-September	June-July
Banvel 520+2,4-D	March	Common nighthawk	May-September	June-July
Banvel 520	March	Rufus Hummingbird	March-July	April-June
Tordon 101	June-July	Common Flicker	year round	April-July
Tordon 10K	Aug-Nov	Flycatcher	April-Sept	April-July
Diuron	March-June	Tree Swallow	Feb-Sept	April-June
Dicamba +2,4-D	Jan-June	Blackcapped chickadee	year round	
Krenite	Aug-Sept	White breasted nuthatch	year round	April-July
Tordon 101R	July-Sept	Winter Wren	year round	May-July
Tordon K & Verton 2-D	---	Varied thrush	Feb-Oct	April-June
Weedone 170	June-Sept	Mountain bluebird	April-Nov	April-July
Banvel	Spring-Summer	Nashville Warbler	April-Sept	April-June
Simazine	February	Western Tanager	April-Sept	April-July
Atrazine	Feb-June	Black-headed grosbeak	April-Sept	April-July
Atrazine and Doupon	Feb-June	Lazuli Buntig	May-Sept	May-June
Atrazine and 2,4-D	March-April	American Goldfinch	April-Oct	June-July
Atrazine & 2,4-D & Dalapon	---	Green-tailed towhee	April-Sept	April-June
Dicamba	Feb-May	Fox Sparrow	April-Sept	May-July
2,4-D	March-Aug			

Morton (1972) fed herbicides to newly emerged worker bees, Apis mellifera L., in 60 percent sucrose syrup at concentrations of 0, 10, 100, and 1,000 parts per million by weight. The following herbicides were relatively nontoxic to honey bees at all concentrations: 2,4-D, 2,4,5-T: silvex; 2,4-DP, dicamba; picloram; and dalapon (USDA).

Data Gap

Reptiles, amphibians and other organisms with limited mobility may not be able to avoid the herbicide treatments. Quantitative data is lacking on the impacts on these vertebrates and invertebrates. Untreated stream buffer zones will provide some protection to these aquatic animals. Most amphibians and reptiles live beneath protective cover which will intercept most of the spray.

Cumulative Impacts

1. There is no known cumulative toxicity impact of herbicides on any wildlife species.

2. Detrimental cumulative buildups of herbicides in food chain organisms are not anticipated. Herbicides used for forest vegetation control are not concentrated in animal organs or tissues to any significant degree. Feeding studies on various animals reveal that herbicides are rapidly excreted (Fisher et al, 1965).

3. The concentration of herbicides residues in vegetation varies greatly after treatment due to plant growth, weathering and metabolism within the plants. Norris, 1965, reported that herbicides residues are not the same in all plants, He also reports that phenoxy herbicides are fairly rapidly degraded.

4. The possibility of toxic reactions to herbicides from feeding (browsing and grazing) animals in treatment units is unlikely during spraying operations and decreases rapidly after treatment.

Conclusions

1. The available literature supports the conclusion of Warren 1967, and Kimmins, 1975, that the toxicity to wildlife of most herbicides used in forestry are rated in the range of moderate to low impact. However, there is little hard data available concerning low-level, long term, and chronic effects of herbicides on wildlife. However, chronic exposure will not result from the proposed action described in Chapter I.

2. Limited research findings report little or no significant bio-accumulation of herbicides in wildlife.

3. There is a slight possibility of an occasional bird, amphibian, or reptile being coated with diesel oil, a herbicide carrier. There is

no data on herbicide and/or herbicide carrier impacts on amphibians and reptiles.

4. Many observers have echoed that if during herbicide treatments adequate environmental controls and adherence to manufacturers label specifications are maintained, few toxicological impacts on wildlife should be encountered.

Wildlife Habitat Impacts

The greatest impact that herbicides have on wildlife, which has been identified to date, is the modification of habitat. This impact takes the form of a loss of habitat diversity and plant community complexity. However, the altering of habitat can be both beneficial and detrimental and varies by wildlife species.

The majority of the 74,500 acres proposed annually for herbicide treatment have already been altered by forest management activities. The wildlife habitat on these areas is a product of the initial logging which has removed the mature forest plant community. The long-term effects of managing forestland for crops of timber on wildlife productivity will be to increase the acreage of forest habitat preferred by big game and other species which depend on the earlier stages of vegetation (see tables 20 and 21). Gouch, 1974, states that shorter crop rotation periods would increase the frequency with which given areas would be logged. Therefore, the number of acres in the

highly productive early seral stages classes would be doubled in a 50 year rotation compared with one of 100 years.

However, it must be recognized that herbicides and other timber management practices are used to accelerate forest succession from seral stages to dominance by conifers. The current objective of intensive forest management is to convert slow growing, decaying, old growth commercial forest stands to young, fast growing Douglas-fir that will be harvested every 80 years on a continuous basis. Much of the present wildlife is found in the old growth forest habitat. The conversion of wild forests to a managed condition reduces vegetative diversity, community structure, and an abbreviated succession of the early plant communities.

The wildlife component of any tract of land is directly related to specific plant communities and the structure and successional stage of the community. Modification of the plant community structure by any method may impact the habitat of the wildlife species present. This impact can be both beneficial or adverse dependent on each species specific habitat requirements. Data is rather limited on the direct impacts of herbicides on population sizes of animals. However, it can be predicted that because of animal relationships to plant communities and its structure that some populations will increase while others decrease.

Generally, the impact to wildlife of a herbicide treatment on forest land depends on the successional stage of the plant community being treated.

Herbicide treatments can be used to advance or retard the successional stage of a plant community. Objectives of herbicides as proposed for use in forestry are to reduce or kill vegetative growth competing with conifer establishment by both advancing and shortening the time period of the early successional stages. The successional stages in which herbicide treatment has the most accelerating effect toward a dominance by conifers are the grass-forb; shrub-seedling; and pole-sapling stages.

Wildlife biologists have for years used herbicides as a tool for habitat manipulation (Coulter, 1958; Ruch, 1957) (Mueggler, 1966) (McCaffery & Johnson 1974). Therefore, at the present time, various wildlife responses to certain habitat modifications can be predicted. Species with specific habitat requirements and low adaptability could be eliminated or forced to move from a treated area, while the more adaptable species may increase. However, it is generally recognized that wildlife species composition changes are a result of plant succession and not the function of herbicide treatment in itself.

Large Mammals

The impact of treating 74,500 acres, annually, of wildlife habitat is expected to produce several responses. Only those key habitat areas of the major animal groupings will be discussed as they relate to areas which are presently cutover and scheduled for treatment.

The proposed treatment areas, generally clearcuts, serve as important big game foraging (feeding) areas while adjacent timbered areas provide cover.

Black-tailed deer and elk densities are highest in these cutover areas during the early stages of plant succession, lasting 10-15 years past logging.

The most significant impact on big game animals of herbicide treatments on cutover forest land is the temporary reduction of forage quantity and quality. If treatment occurred on critical winter ranges for big game, the adverse impact could be severe.

Gouch, 1964 and Hines, 1973, have found that in the Tillamook Burn, Oregon, there is a natural seasonal reduction of deer forage availability up to 90 percent in the period late fall to spring. This seasonal forage loss may vary by sub-biome due to environmental conditions, such as sunlight and soils.

Herbicide treatments on western Oregon cutover lands may compound this natural seasonal reduction of available forage.

Generally this reduction in big game forage availability is temporary, lasting from 3 to 5 years.

Several Oregon authors have concluded that herbicide treatments in general provide improved habitat for the larger animals. In 1970 Black found that deer use increased on the treated areas, one year past treatment, in a greater proportion than on untreated areas. Borrecco (1973) found similar results with black-tail deer and related his findings to a temporary suppression of browse species.

Harper (1971) reported that in western Oregon elk were adersely affected when ground forage was removed by herbicides, but were benefited by opening up of dense brushfields. In this study, many of the mature shrubs were not killed but just set back by herbicide treatments and many re-sprouted providing excellent forage for deer and elk.

However, Mueggler, 1966, used a mixture of 24-D and 2,4,5T in northern Idaho, to determine the impacts and opportunities to improve wildlife habitat. Contrary to Harper's findings, Lyon and Mueggler, 1968, found on reevaluation of a herbicide study area, 6 years post treatment, that the long term impact was a lag in plant mortality of undesirable species. Desirable species exhibited poor persistence of sprouting and quick recovery from crown dieback. Plants with crown ditback tend to basal sprut more readily. The most desirable browse (Redstem ceanothus) Ceanothus Sanguineus was killed by all treatments. However, it should be noted that redstem is generally a poor sprouter. Weather conditions in Idaho may cause results dissimilar to that which might be expected in humid western Oregon environments.

In western Oregon, much of the harvested coniferous forest land tends to proceed to a succession stage of brush with a dense canopy reaching ten or more feet off the ground unless successfully reforested. Wildlife forage is practically unavailable under this type of vegetative structure because the palatable forbs and browse is shaded out. The palatability of plants growing under a dense canopy, in limited sunlight, have reduced nutritive value in relation to those growing in the earlier grass-forb successional stage. Therefore, the overall effect of herbicide treatments used in most forest applications is usually the shortening of the grass-forb forage and brush producing stages in favor of a general advancement of the conifer stage. During the pediod after the conifer release forbs flourish for a few years until brush or conifer invade and shade out other vegetation.

However, the range of selectivity of some herbicides proposed for use is only moderately described in the literature. Response of non target vegetation is not as well documented. Quite often the vegetation which the forest manager seeks to destroy or retard is the wildlife manager's ice cream plant - a preferred wildlife forage item (see table 18 in Chapter II). All the herbicide target species are utilized to some extent by wildlife as forage items. See table 23 in Chapter II for a listing of target species. Two herbicides, 2,4-D and Silvex, are proposed for use in 1978, both singly and in combination, on approximately 50,000 acres. Use of these herbicides for site preparation reduces herbaceous vegetation (grasses, forbs, and shrubs) on the target area. As noted previously, Ceanothus species are important big game browse plants. The use of the 2,4-D and Silvex combination results in high mortality of these plants.

Newton (1974) describes using combination of herbicides to obtain optimum control of weed species. Combinations of atrazine, dalapon, and 2,4-D are used to provide a high degree and a wider range of control of grasses and "weeds" which are resistant to the above herbicides used individually. Herbicide treatment proposed by this document include using combinations of herbicides on 8,300 acres with the primary emphasis the removal of grasses and forbs. Harper, 1971, described the seasonal importance of forbs in the diet of elk. Retreatments further reduce the capability of the site to support wildlife. The ability of native vegetation to resprout or reinvade a treated site will influence this impact and can vary by sub-biomes. It should be noted here that the results of herbicide treatments vary by chemical used and by target species. It is estimated that on an average herbicide project, the first year impact is a 50-75 percent reduction in forage. Browse forage production is severely reduced with some plants killed while others respond with reduced growth. However, because of the diversity of vegetation and excellent growing conditions found in western Oregon, few if any sites will be completely devoid of vegetation.

Forage loss is mitigated by several factors which may vary in degree of impact by sub-biome. Natural plant succession continues after herbicide treatments and a reinvasion of native vegetation occurs within a 3-5 year period. Some plants resprout the first growing season past spray. Many winter and summer active forbs and grasses, which are protected from the treatment by the overstory target plants, continue to provide forage. Untreated stream buffer zones also provide a forage reserve for wildlife.

Some of the crucial winter ranges for deer and elk in western Oregon are on BLM lands located at the lower elevational zones. The ranges have not all been identified. Some of these areas may be in the proposed action if they have not been identified. This habitat is usually the dominant limiting factor affecting the survival of resident big game populations. On these areas the resident wildlife populations are under stress due to limited forage, cover and other environmental factors. Herbicide treatments could impact the escape and thermal cover requirements of deer and elk. Destruction of escape cover tends to make many species of wildlife more vulnerable to predation or harassment by man. In areas where forage and cover are already limited, any further reduction in availability could result in increased competition for the remaining habitat. Thomas, et. al. 1977, recommend a 60/40 percent forage-cover ratio. Loss or reduction of browse plants on crucial big game winter ranges may also cause animal mortality indirectly when deep snows cover ground vegetation. Some large mammals with small home ranges are reluctant to leave historical areas even if adjacent suitable habitat is available. Competition can also lead to stress and stress can lead to mortality.

The impact of proposed herbicide treatments in western Oregon, on crucial winter ranges is not easy to assess due to a lack of knowledge on the location and general extent of the areas involved.

Another key big game habitat which could be impacted by nerbicides is calving or fawning areas. Like the winter range areas these areas have not been quantified or identified. Calving and fawning areas are often

found associated with stream riparian zones, meadows, and edge or ecotone area involving cutover areas and old growth habitat. In the proposed action many of these areas may receive protection or be non-target areas incidentally due to project design features to protect water quality such as buffer zone protection.

Small Mammals

In the cases cited in the literature small mammals reacted differently to herbicide treatments than did larger mammals. Black found fewer small mammals and birds on treated sites after the vegetation was decreased by herbicides which reduced the available cover, and as the vegetation recovered, so did the animal populations.

In other studies, Black and Hooven (1974) found that herbicide effects on small mammal populations in the mixed conifer region of wouthwestern Oregon was somewhat different. Populations remained similar between treated and nontreated plots except for pocket gophers, which decreased on treated sites.

Borrecco (1973) reported differential responses of mammals to herbicide treated areas in the Douglas-fir region of western Oregon. Meadow voles, vargrant shrews and jumping mice decreased while deer mice and trowbridge shrews increased. These population changes were related directly to habitat modification which was characterized by elimination of annual grasses, partial

reduction of forbs and perennial grasses and temporary suppression of browse species. Follow-up studies on Borrecco's plots by Black and Hooven (1974) showed that within 2 years or less, treated habitats had returned to normal, and composition of small mammal communities on treated plots was similar to untreated plots.

Birds

The overall impact of herbicide treatments on avian populations is expected to cause habitat loss and reductions which in turn will be reflected in reduced population stability and diversity.

Key avian habitat components being analyzed in this section include nesting, feeding and roosting habitat. Also, the timing of herbicide applitation periods with peak periods of bird migration and nesting will be discussed. Beaver (1976) reported in his Northern California study, that birds adapted to spray areas and shifted their diets. The study area was treated by helicopter using a formulation of 1.8 kg acid equivalent, low volatile, 2,4,5T.

Beaver also found that all the species of birds occurring in brush-fields are restricted to the use of bushes for feeding and nesting. However, no clear difference was found between herbicide spray plots on the avian population on unsprayed brush fields. No effect of the herbicide treatment was discernable on avian species composition, population size or relative abundance on plots studied.

However, in a more recent study conducted in the same area as Beaver's work, different results have been reported. Savidge (submitted for publication 1977) initiated a pilot study to determine the long term impacts (6 years post spray) of herbicides on vegetation and animal populations. In summary, Savidge's study concluded that herbicide spraying caused changes in the composition and density of the shrub layer which in turn reflected changes in animal populations. The total number of birds on the unsprayed control plots was found to be twice that of the sprayed plots. Species diversity was lower on the sprayed plots (table 35).

Findings by Savidge support and provide some quantification to Meslow and Wight's 1975 theory that herbicides can "have drastic impacts on the carrying capacity of the area for wildlife; both numbers and diversity of birds will be markedly reduced".

As shown in Chapter II, Meslow and Wight, 1975, have reported the avian species which are primarily dependent on the grass-forb, shrub-sapling successional stages for nesting. The proposed action will treat 17,245 acres of the grass seral stage and 54,427 acres of the brush stage. Therefore, we can predict a population decline in those species which have the early seral stages as their primary habitat requirement. Modification of the various plant communities in the above stages may cause a decline in the bird population in the treated area. This impact may be reduced because birds are mobile and can shift to similar habitat. However, if immigrating birds find the new habitat occupied at carrying capacity, then, theoretically mortality could result.

Table 35

Bird populations on the study plots. V = rare or vagrant
(Savidge, 1977)

Species	No. pairs per 40.5 ha Unsprayed	Sprayed
Robin (Turdus migratoriu)	5	9
Mountain Bluebird (Sialia currucoides)	3	5
Cassin Finch (Carpodaus cassinii)	V	5
Green-tailed Towhee (Chlorura chlorura)	18	22
Fox Sparrow (Passerella iliaca)	98	40
Brewer's Sparrow (Spizella breweri)	45	22
Dusky Flycatcher (Empidonax oberholseri)	22	18
Yellow Warbler (Dendroica penechniq)	27	V
Lazul Bunting (passerina amoena)	13	-
Mountain Quail (Oreortyx pictus)	5	-
Mourning Dove (Zenaidura macroura)	9	-
Chipping Saprrow (Spizella passerina)	5	-
Black-headed Grosbeak (pheucticum melanocephalus)	5	-
Dark-eyed Junco (Junco hyemalis)	9	5
Common Flicker (Colaptes caffer)	2	V
TOTALS	263	125
Number of Species	14	8
Diversity	2.03	1.81

In Savidge's study Ceanothus velutinus constituted the dominant brush, while in BLMs 1978 herbicide program proposal, Ceanothus is a target species on only 9,088 acres which represents 8% of the total proposed action. One point to consider here is the relationship or applicability of the California study area to the more humid regions of western Oregon. However, we must consider the possibility of results similar to Savidges on sites in Oregon where different vegetative communities react in a similar manner. This may result where combinations of chemicals are used or on sites which receive several treatments.

Many other variables influence the results of herbicide treatments some include phenology of target plants, spray application period, weather conditions and region of the state.

Many observers have reported that all vegetation on herbicide treatment site is not killed, and forage and cover remains. It is also noted that the remaining dead plants continue to provide cover. However, the results of a herbicide treatment will usually change each year succeeding treatment. The impacts on wildlife may likewise change.

Beaver (1976) reports that as a result of foliage herbicide treatments the leaves on certain vegetation turn brown and are often retained. Thus, the cover characteristics are maintained while the food producing capability may be lost. In succeeding years the shrubs may not provide nesting cover for birds or hiding cover for big game animals. However, in some regions the

brush usually re-invades the site in a few years. Six years past spray, Savidge, found that the brush no longer provided nesting sites or cover. Bird species composition had also changed since Beaver's study with four species found to be absent. These species included Lazula Bunting, Yellow warbler, Mourning dove and Mountain quail.

An impact not identified directly in the literature is the possibility of herbicide applications coinciding with the presence of the highest occurrence and diversity of birds. Table 36 illustrates the overlap of herbicide application period and the reproductive period of some forest birds. Spraying during the reproductive period may cause birds to abort nest and also allow herbicides to contaminate eggs. Timing of the early and late foliar spray periods may offer the greatest conflict between nesting season of the majority of species and herbicide application periods. However, only 14 percent of BLM's proposed treatment program is scheduled to be done during the bud-break or dormant period, and thus prior to bird nesting season. Therefore, the imact on nesting birds will be minimal.

Many raptors and herons are early spring nesters and care should be taken to avoid low aircraft flights in the near vicinity of identified nest sites. The bald eagle, redtail hawk, osprey, and heron initiate nesting in February or early March in the Pacific Northwest. Low flying treatment aircraft could cause the birds to abort nesting.

Table 36

Relationship of Proposed Herbicide Application Periods to Peak Avian Reproductive Seasons

Herbicide	General Chemical Application Period
Silvex	Feb-Sep
Silvex + 2,4-D	Mar-Oct
Banvel 520 + 2,4-D	March
Banvel 520	March
Tordon 101	June-July
Tordon 10K	Aug-Nov
Diuron	March-June
Dicamba + 2,4-D	Jan-June
Drenite	Aug-Sept
Tordon 101R	July-Sept
Tordon K & Verton 2-D	_____
Weedone 170	June-Sept
Banvel 720	Spring-summer
Simazine	Feb
Atrazine	Feb-June
Atrazine and Doupon	Feb-June
Atrazine and 2,4-D Dalapon	
Dicamba	Feb-May
2,4-D	March-Aug

Table 36 (concluded)

	Season of Occurrence	Reproductive Period
Osprey	Feb-October	April-July
Poorwill	April-September	June-July
Common nighthawk	May-September	June-July
Rufus Hummingbird	March-July	April-June
Common flicker	year round	April-July
Flycatcher	April-Sep	April-July
Tree Swallow	Feb-Sept	April-June
Blackcapped chickadee	year round	
White breasted nuthatch	year round	April-July
Winter Wren	year round	May-July
Varied thrush	Feb-Oct	April-June
Mountain bluebird	April-Nov	April-July
Nashville Warbler	April-Sept	April-June
Western Tanager	April-Sept	April-July
Black-headed grosbeak	April-Sept	April-July
Lazuli Bunting	May-Sept	May-June
American Goldfinch	April-Oct	June-July
Green-tailed towhee	April-Sept	April-June
Fox Sparrow	April-Sept	May-July

Generally, most nesting sites of these species are not found within cutover areas, but are closely associated with riparian habitats. These riparian habitats receive some protection through BLM stream buffer zone policy.

The removal of snags is known to reduce populations of some birds (Beebe 1974, Mannan, 1977). Snags or dead trees are another key wildlife habitat which has already undergone drastic reduction during initial logging operations. Generally, snags are removed concurrently with logging operations and few snags remain in the proposed treatment areas. However, recently developed snag policies have directed that snags be left where they do not constitute a safety hazard to logging. In some cases, proposed herbicide treatment project require the remaining or "preserved" snags to be felled to allow for aerial application of herbicides. This loss of snags represents an additional depletion of this crucial habitat. Jackman, 1974 has reported that 40 percent of the "forest birds" are dependent on cavities. She also points out that "in coniferous forests about 20 percent of the total breeding pairs nest in holes." Several mammals, reptiles, amphibian and insects also utilize dead decaying trees at some time.

Competition between birds for nesting cavities has been noted on some forest regions. The specific project design features that aircraft fly 30-45 feet above vegetation. Therefore, snags can be retained that are under 15 feet tall and still meet the requirements of the State of Oregon safety laws that snags over 15 feet high be felled. In steep terrain it may be more difficult to leave snags.

During 1978, aerial application of herbicides is proposed on 64,258 acres or 85 percent of the entire proposed acreage. Thus, if BLM snag guidelines have been met during the original logging, and no deterioration has taken place, some 20,000 snags (1 snag for each 3 acres of commercial forest land) could be present on these areas. However, this does not represent the actual situation due to several factors; few tall snags are maintained after clearcutting, safety laws, and the BLM snag policy didn't become effective until May, 1976. In addition, many of the proposed treatment areas are backlog areas that did not have snags specifically preserved or set aside for wildlife.

Mannan, 1977 found in western Oregon that hole nesting birds foraged on and nested in Douglas fir snags averaging over 60 cm. in dbh. (diameter breast high). This snag size was generally found in forests over 70 years of age. He also reported that cavity nesting bird use was concentrated in forests 100-200+ years old.

Generally, the long term goal on the intensively managed BLM forest land is aimed at harvesting timber between the ages of 60 to 100 years. This practice will not permit time for the large snags to develop that are now found in old stands of trees. Because snag recruitment is a slow process, the herbicide program could have a long term impact on the abundance and diversity of dependent species if all snags on proposed treatment areas were required to be cut. It is predicted that few of the 745,000 acres projected to be treated with herbicides during the next 10 years will have adequate numbers of wildlife snags remaining.

Riparian Habitat

Herbicide applications in the close proximity of riparian habitat may have an adverse impact on riparian wildlife if adequate buffer zones are not maintained. The drift of herbicides into desirable riparian vegetation could destroy or injure some of the aquatic foods on which aquatic birds depend. Wildlife diversity is most prevalent in association with the riparian plant community. Alteration of this habitat may affect all the major components of wildlife habitat; food, water, and cover. The quantification of impact is difficult because no field studies of this potential situation have been conducted.

Riparian or stream vegetation is the key to wildlife survival on some crucial deer and elk winter ranges. Generally, birds and mammals move to lower elevations during winter storm periods. During this season the use of this habitat is extremely important. The loss or reduction of this vegetative community through any action in crucial areas may cause some animals to suffer from exposure and perish. Also the use of defoliants such as 2,4-D, and Silvex on large stands of alder and other hardwoods will remove necessary summer escape cover used by deer, elk, other animals and birds (BLM, TM, EIS 1975). Smith, 1974, has illustrated that the impact of several chemicals and combinations used on alder produces an extremely high percentage of dead plants.

In western Oregon the forestry objective of some specific herbicide treatments (table 1, Chapter I) is the removal of competing vegetation; mainly alder. Alder is a water tolerant tree which is usually found associated with the riparian plant community and on moist north slopes. Alders commonly invade recently harvested areas in the Northwest Coniferous Biome that are on slopes adjacent to stream side Alder stands. Alders provide for the cavity nesters niche in lieu of conifers in many stream side buffer zones. Woodpeckers and other cavity nesters hollow out nesting cavities in the semi-rotten alder trees. Alders are rather shortlived when compared with conifers and other hardwoods, however, they have a rapid initial growth rate. When growing with dominant conifers they eventually die out. These trees are an important source of nesting sites for many animals. Amphibians and reptiles also utilize downed trees for cover and a source of insect food items. Many seed eating birds, such as the Black-capped Chickadee, make extensive use of alder seeds during fall and winter periods.

Conifer release projects proposed during FY 1978 are directed at 45,919 acres. Of this total 43,000 acres involve mostly non-riparian alder and big leaf maple control. Any impact of this action on riparian zone cavity nesters and other dependent wildlife is largely offset through BLM's stream side buffer zone protection policy.

Other Impacts

Animals are disturbed by helicopters and human activity during spray operations. Large animals leave and enter the nearest protective cover.

Birds fly away, small mammals head for cover under logs or into the ground. This disturbance can be a problem at critical periods during mating, calving, or nesting season. Through careful planning, critical areas will be either avoided or deferred as necessary.

Large mammals have been found to leave the project site while machinery and men are in the vicinity. Both deer and elk will move into the adjacent untreated areas until the disturbance subsides and then return.

Endangered and Threatened Species

No confirmed crucial habitat of any Federally or State listed animals have been identified in the close proximity of any planned herbicide treatment areas. Most of the listed species depend on habitat types other than those proposed for treatment. Some incidental use of treatment areas for feeding may occur. The northern bald eagle and the northern spotted owl may fly through the treatment sites, however these species generally do not nest in this type of habitat.

The Bureau will comply with the Endangered Species Act of 1973. All specific proposed herbicide projects will be evaluated as to their impact on the listed species. If crucial habitat of these species are identified at a later date, there will be no herbicide treatment in those areas or in any areas officially designated as "occupied habitat" for these species until studies prove the herbicides would not have adverse effects on these species or their habitats.

Cumulative Impacts - Habitat

If the herbicide use pattern is implemented as proposed throughout the next decade, two major cumulative impacts on animal habitat are anticipated: these are forage and snag reductions.

1. The most significant cumulative impact of this action will be habitat loss occurring mainly on those acres requiring repeated treatments. On these areas, the secondary spray results are increasingly effective due to forage being removed by the initial treatment. The loss of canopy vegetation allows deeper penetration of the herbicide which in turn causes further loss of vegetative structure and diversity required by some wildlife species.

2. The habitat of cavity nesting animals may be reduced on those areas (less the acres treated by ground crews) where aerial application of herbicides is involved and all snags are felled as a safety measure for application aircraft.

Conclusion - Wildlife Habitat

The overall impact of herbicides on wildlife habitat is difficult to assess. Any reduction in vegetative abundance, density, structure, size or vigor will have some degree of impact on wildlife habitat. The resulting impact on animals will vary by species, with some species increasing and other declining.

Herbicides used as a tool of intensive forestry modifies the natural succession through which plant communities progress. Two reactions occur: (1) in the long term, the early seral stages are shortened with an overall rapid advancement of coniferous succession, (2) a major short term impact on dense, mature brush vegetation is regression of plant succession to the earlier grass-forb stage. Plant response period to herbicide may differ to some degree by sub-biomes with the slowest regrowth occurring in the broad sclerophyll biome.

Wildlife responses to vegetative community changes is a complex subject with many interrelationships and unanswered questions. Generally, only limited long-term impact is expected on the larger mammals and birds due to their mobility, with many species ranging throughout Oregon. Population declines are expected to occur to those animals found closely associated with the habitat types being treated.

The proposed action will have the following specific adverse and beneficial impacts on wildlife or wildlife habitat associated with proposed treatment areas.

Adverse:

1. Wildlife forage quantities will be reduced on treated sites resulting in lower carrying capacities for some species.

2. The forage productivity periods resulting from natural succession will be shortened by 5 to 10 years on proposed treatment areas. This is dependent by sub-biome. This will result in peak wildlife densities not spanning as many years on treatment areas.

3. The habitat of cavity dwelling animals will be reduced by the loss of snags.

4. There will be a decline in the number and diversity of birds.

5. Crucial big game winter ranges and/or calving and fawning areas may be treated with herbicides to the detriment of these animals.

6. Some herbicides are being applied during avian nesting and reproduction periods. Impacts are unknown, but thought to be adverse.

Beneficial:

1. Short term forage increases for big game due to the set back of succession on some cutover areas, which are dominated by dense brush.

SOIL

Applied herbicides that haven't been absorbed by plant roots, and absorbed or degraded in the soil complex are available for surface runoff, leaching or piping. Although, except for soil active chemicals, such as atrazine, to be applied on 14,945 acres for control of grasses, foliar interception of applied spray will occur so that amounts which reach the soil will be very minute. In addition, dense vegetative cover, forest floor litter, and the high infiltration and permeability rates common to most undisturbed soils in western Oregon are deterrents to the movement of herbicides. There remains the possibility that herbicides adsorbed to soil particles can become detached and transported in overland water flow.

However, applications to bare soil areas which have been compacted due to timber harvest and road building activities present the greatest hazard of losing chemical residues during runoffs either in solution or attached to soil particles. Stewart (1976) has accurately pointed out that since herbicides by themselves do not remove litter layers, stems, branches, or roots they have less effect on soil erosion than other alternatives such as mechanical scarification. He adds that the herbicides used do not affect all plant species equally so accelerated erosion is unlikely and aerial spraying should have little effect on soil losses and related long-term productivity. The leaching or movement of herbicides in the soil with water is a factor to be considered in not only obtaining their maximum effectiveness but projecting their potential impact on water supplies. This movement is related to the adsorption of

the chemicals and to the amount and intensity of water movement. Adsorption properties of soil increase and the leachability decreases as soil textures go from sand, to loam, to clay and as organic matter increases. For this reason treatment areas located on Siskiyou gravelly sandy loam soils in the Klamath Mountains, which are somewhat excessively drained, have a greater leaching hazard than would those located over Jory silty clay loam soils, moderately well drained soil, occurring in foothills along interior valleys. (See table 25 pertaining to extensive soils found in each sub-biome and figure 4, a general soil map of western Oregon in Chapter II.) In addition, as a general rule, compounds of high water solubility (dicamba, krenite, and atrazine) move most rapidly in the soil, while those of low water solubility or those strongly adsorbed by the soil complex, move slowly. Also in considering the potential impacts due to leaching the amount of water available to pass through the soil profile and the rapidity with which it is capable of moving through the soil is assessed.

A leaching hazard of chemicals does exist in shallow, stony, excessively drained soils with late winter or early spring applications in a high rainfall zone. Also if these soils occur over impervious or slowly pervious bedrock the related ground-water supplies and streams could be impacted.

Phenoxy herbicides, namely 2,4-D and Silvex have been shown to be quickly absorbed in the soil colloidal complexes so they aren't available for leaching to any extent but, are degraded rapidly by microbial activity (Newman and Thomas, 1950; Norris, 1966; Norris, 1967; and Bailey et al, 1970).

2,4-D is degraded by 85 to 90 per cent within 15 days and Silvex has a residual half life less than eight months.

The TCDD contaminant in Silvex once in the soil becomes tightly adsorbed to the clay minerals and organic matter and isn't appreciably absorbed by plants. "The TCDD does not leach downward but, remains localized in the surface soil. The concentration at this time is less than one part in 10 trillion. Microbial degradation then comes into play and decomposes the remaining chemical to basic materials over a period of probably a year or two (Kearney, 1976)."

Kozlowski and Kuntz (1973) found that "when Plainfield sand to which atrazine, simazine, or propazine was surface-applied and leached, most of the herbicide remained in the first inch of soil regardless of whether 2, 4, or 8 inches of water were used in leaching. However, some herbicides, especially atrazine, moved downward to a 6-inch depth. With increased amount of leaching more herbicide was translocated out of the first inch of atrazine-treated soil. Such an effect was not as apparent with simazine- or propazine-treated soil. The greater leachability of atrazine was probably related to its greater solubility." "This study, which demonstrates the difficulty of removing triazine herbicides from upper soil levels even with large amounts of water, emphasizes the dangers of possible persistence and accumulation of triazine herbicides in forest nurseries, even in light sandy soils."

Atrazine is more readily adsorbed on clay soils than on soils of low clay and organic matter content. The downward movement or leaching is limited by its adsorption to certain soil constituents. Adsorption is not irreversible and desorption often occurs readily, depending on temperature, moisture, pH, etc. Atrazine is not normally found below the upper foot of soil in detectable quantities, even after years of continuous use. Although its use is best restricted to clayey textured soils and not applied where excessively drained, shallow, stony soils with little clay or organic matter occur extensively because of the hazard of leaching residues into ground water supplies.

The residual activity of atrazine in soil at selective rates for specific soil types is such that most rotational crops can be planted one year after application except under an arid or semiarid climate. Atrazine will persist longer under dry (Xeric) and cold (Frigid) conditions or conditions not conducive to maximum chemical or biological activity. Broadcast rates needed in some of the heavier organic natter soils of the North Central states result in enough residue carryover, under some conditions, to injure small grains, alfalfa, and soybeans planted 12 months later. Plant removal and chemical alteration are factors in dissipation but, microbial action probably accounts for the major breakdown of atrazine in the soil. A range of soil microorganisms can utilize it as a source of energy and nitrogen and the effects of atrazine on these and other organisms appear to be small.

Thiegs (1955) showed that the breakdown of dalapon in soils is due to micro biological action. Dalapon was found to decompose most rapidly in warm,

moist soils, whereas in cool or dry soils the herbicides remained for extended periods.

Day, Jordan, and Russell (1963) report on the persistence of dalapon under laboratory conditions in 43 soils collected from California citrus districts. The rates of decomposition of dalapon were highly variable among the soils studied, apparently due to differences in the population of soil microorganisms capable of decomposing dalapon. Decomposition of dalapon ranged from complete disappearance in less than 2 weeks to the retention of 2/3 of the added dalapon after 8 weeks. The capacity of the soil to decompose dalapon was essentially random with respect to soil series, texture, cation-exchange capacity, total organic matter, and geographical source.

Proposed applications in 1978 using Tordon on 5,966 acres involve frill and stump treatments, pellet distribution and aerial spray. Application rates range in acid equivalency from less than one ounce to about five pounds per acre depending upon the treatment. However, the amounts of this chemical becoming in contact with soil is projected to be much less than this. Studies of persistence of Tordon in soils (Hamaker, 1967) have shown that with initial rates of 1 ounce and 2 pounds acid equivalent per acre, the time for decomposition to concentrations of 0.01 ounces per acre would be 4.5 months and 4.6 years, respectively. The half-life in soil of a herbicide may be a better measure of persistence. Half-life is the time that is required for half of the herbicde applied to the soil to be inactivated or to disappear. Tordon degrades in soils with a variable half-life of from 1 to 13 months (Goring,

1965). Most investigators agree that dissipation is accelerated at higher temperatures (Bovey and Scifres, 1971). Norris (1969) noted that in an area where 67 per cent of a watershed was sprayed in August, residues up to a maximum of 0.078 ppm were detected after the initial 1 inch storm and they decreased thereafter. No residues were found after late October or where only a small portion of the watershed was treated. Residues of Tordon in woody plants in tropical areas ranged from 31 to 687 ppm immediately after spraying 2 pounds of active ingredient per acre but dropped to less than 1 ppm a month later (Bovey and Scrifres, 1971).

Diuron, another of the organic herbicides, is strongly adsorped in the soil and has a rather low water solubility and it to leaches very slowly. Also because it is degraded very slowly by microorganisms it will have a long residual life.

Greenhouse soil disappearance tests with 14C-labeled Krenite indicated about a 10-day half-life. Under field tests the half-life was about 1 week. Because of rapid degradation there was little or no downward movement of Krenite or its degradation products (Du Pont, 1976) but, since this product is quite soluble in water, as is dicamba, the amount and intensity of rainfall the first 24 hours following application is highly important. So the weather forecasts should be closely followed before application is permitted.

Monsanto (1975) reports Roundup to be somewhat strongly bound to soil particles; does not leach appreciably; and that after using a four and eight

pound per acre application rate the residual half life was found to be less than two months in ten of their eleven test locations.

Cumulative Impacts

The persistance of herbicides in the soil varies depending on the herbicide and the soil. Half-life times range from less than 4 months to 12 months (table 31). No cumulative impacts are expected to result from the use of herbicides as described in Chapter I.

Conclusions

Documented evidence indicates herbicide impacts to soils to be of little significance (Abrahamson and Norris, 1976). At application rates normally used for the selected chemicals and the planned project design features presented in Chapter 1, no significant soil related impacts are anticipated. However, (1) a potential for herbicide loss does exist from compacted bare soil areas due to run off in solution or as attached to soil particles and (2) from leaching in shallow, stony, rapidly drained soils.

SOIL ORGANISMS

Researchers have found that soil microorganisms are important in the breakdown of herbicides in the soil (Audus, 1964). Phenoxy herbicides are

very susceptible to soil breakdown (Bollen, 1961); and 2,4-D and Tordon are all degradable in forest litter, although at markedly different rates. Recovery of 2,4-D dropped to 6 per cent after 35 days while in contrast after 180 days, 65 per cent of the Tordon remains in the litter (Norris, 1970b). Dicamba, subject to both biological and chemical degradation, is reported to be relatively nonpersistent in the soil (Erne, 1971). Tordon is degraded in plants, soil, and pure cultures of microorganisms (Goring and Hamaker, 1971).

Additions of herbicides to soil have a measurable effect on the microbial activity in the soil. It is not clear if this effect is caused by the presence of the herbicide or if the effect is a result of using the herbicide as an energy source for microorganisims. Only a minute amount of aerially applied herbicide effectively comes in contact with the soil when applied for brush control. Particularly when mixed with an oil carrier which facilitates adherence to vegetative cover. In effect only about 3 ppm will be found in the soil surface for each pound of chemical applied (Norris, 1971). Although essentially all applied atrazine in a water carrier reaches contact with soil. Oxygen consumption of soil organisms in a loamy soil was measured as an indication of the effect of herbicides on the microflora (Whiteside and Alexander, 1960). Another study has shown that 2,4-D concentrations up to 10 ppm did not affect respiration (Whiteside and Alexander, 1960). The effects of 2,4-D on soil-borne actinomycetes were measured and some strains were adversely affected by a concentration of 400 ppm (Baldacci and Amici, 1954). Fungi are apparently more resistant to phenoxy herbicides than bacteria (Stephenson and Mitchell, 1945). 2,4-D applied to silt loam soil at rates of

1 to 4 pounds per acre did not have a significant effect on the microorganisms (Kratochvil, 19510. The results of studies on the effect of Tordon on 46 different soil microorganisms indicated that concentrations up to 1,000 parts per million retarded growth and development of only one of the organisms studied (Goring et. al., 1967). Also, it has been found that Tordon had little obvious effect on ammonification, nitrification, sulfur oxidation and organic matter decomposition at concentrations up to 1,000 ppm (Tu and Bollen).

When Krenite was introduced at 4 and 20 ppm to two soil types in laboratory biometer flask tests to evaluate microbial degration, the tests showed that carbon labeled CO_2 accounted for 45 to 75 per cent of the original weight of labeled carbon after 90-day incubations.

Cumulative Impacts

Some microorganisms are capable of degrading various herbicides, thus preventing accumulations of the herbicide in the soil.

Conclusion

There is no evidence to indicate that the herbicides, applied at the recommended rates, will have significant effects upon soil microbial populations (Bollen, 1961 and Cullimore, 1971).

AQUATIC ORGANISMS

Aquatic and Riparian Vegetation

The proposed herbicide application by all methods to approximately 74,500 acres annually have a potential for impact on both aquatic and riparian plants located within the proposed treatment areas. Aerial (62,699 Acres), truck (1,825 acres), and back pack (5,714 acres) applications have the greatest potential, in that order, for impacts resulting from misplacement of herbicides on aquatic and riparian vegetation. The impact of hand injection-methods (4,179 acres) is expected to be negligible. However, hand application can also kill or damage specific riparian vegetation that extends beyond the widths of buffer strip listed for protection in the proposed action.

The 74,500 acres proposed for treatment annually is located in mountainous terrain with a vast dendritic drainage pattern. Calculations indicate that approximately 1,075 miles of streams (refer to treatment area maps appendix d) of varying sizes adjacent and within the areas proposed for herbicide application have the potential to be impacted due to their close proximity. Stream mileage calculations are based on approximately 9.3 miles of intermittent and perennial stream per square mile in western Oregon, therefore:

$$\frac{\text{74,500 Acres in proposed action}}{\text{640 Acres/sq. mile}} \times \text{9.3 miles of stream/sq. mile} =$$

1,075 miles of stream potentially in the area of the proposed action.

The plants commonly found in the aquatic and riparian environment in the three Western Oregon Biomes are listed in Chapter II.

Aquatic Plants - Submerged and Floating

The various studies of herbicide entry into the aquatic ecosystem indicate that low level, short term contact with aquatic plants will occur (see chapter II for list of aquatic plants). However, studies indicate that no measurable damage can be expected to submerged or floating aquatic plants as a result of forest herbicide applications. The experience of aquatic weed control experts can be used to draw some inferences about the impacts that might be expected.

The control of aquatic plants in flowing water with chemicals has been difficult and relatively unsuccessful. The most success in aquatic weed control occurs in still water such as lakes and ponds (EPA 1974). Agricultural researchers have commonly recorded short term occurrence of 2-4-D in irrigation water following ditch bank spraying. Levels at 0.01 ppm commonly occur but have no effect on submerged and floating aquatic plants in the channel. The contact period is relatively short, i.e., a few hours to a few days. Herbicides applied continuously at low levels to flowing ditch water for several months have controlled submerged plants (EPA 1974).

Concentration levels of herbicide 2-4-D needed to kill submerged aquatic plants under the best situation (still water) are at levels around 0.36 ppm (or 1 lb./acre foot).

The entry of herbicide to the drainage ways will be in low levels and for short duration based on past studies by all researchers. Therefore, contact will be short term and below levels sufficient to measurably affect this group of plants. The stream flows are such that dilution will also reduce any potential impact. It is apparent that levels needed to effectively control aquatic plants are much higher than permissible under the standards established by EPA. (See table 37 for recommended forest stream contamination maxima.)

The 74,500 acres proposed for treatment annually may contain approximately 1,075 miles of stream of which 890 are intermittent and 185 are perennial. The summer and early fall application of herbicide proposed in 1978 to 12,891 acres will be during a period when only 32 miles of stream are flowing. This will substantially reduce the potential contact with aquatic plants from contaminated water entering the drainways. However, the relatively large amount of water in streams that are flowing will cause more dilution which lessens the impacts on aquatic plants. The use of buffer strips as described in Chapter I will also reduce potential contamination.

Riparian Vegetation

Application of herbicides used to defoliate brush and undesirable trees (see vegetation portion of chapter III) can have a much greater effect on riparian vegetation than herbicides used to control grass. Riparian zones are those areas associated with surface water that reveal through the vegetative complex (riparian vegetation), the influences of that water. (See chapter II, Aquatic and Riparian Vegetation.)

The effect will depend upon the chemical used, season of use and carrier. It is possible that under certain of these circumstances, no damage would be done, i.e., spraying madrona with 2-4-D in an oil and water emulsion as a dormant application in late March and early April will not affect riparian alder that is within the project area.

Herbicides used for grass control are the least likely to impact the riparian vegetation because most riparian zones are composed of shrubs and trees that are not affected by these herbicides.

Effect of Aerial Application on Riparian Vegetation

The proposed action will require buffer strips at least 100 feet wide on each side of any Class I stream, body of water or marsh when aerially applying herbicides and 200 feet when silvex is applied. (Approximately 70.4 miles of class I streams will be in or near the spray areas.) Buffer strips are also

required along streams not designated as Class I. However, the width may be variable. The vegetation along all streams around bodies of water and marshes is known to provide the nutrient base for aquatic life in these waters (Sedell et al, 1973) (Fisher and Liken, 1973). The removal or destruction of any of this riparian vegetation will reduce the amount of terrestrial and aquatic life in the area of impact (Thomas, Maser and Rodick, 1976). However, there is no data available to quantify the size of the reduction that will occur.

Application of aquatic insect food habitat data to coho food habits indicated that 66% of the total energy intake leading to coho production was derived, either directly as terrestrial insects or indirectly as aquatic insects that feed on terrestrial detritus, i.e., riparian zone vegetation (Chapman, 1961).

However, the proposed action does not specifically address the protection of riparian zones. The BLM is presently drafting manual 1705 Wetland-Riparian Habitat Management which will provide definition and direction for the management of this part of the ecosystem. Many riparian zones are wider than 100 feet along Class I streams at variable intervals. Those portions in proposed treatment areas outside the buffer strips will receive herbicide treatment and in cases where brush control chemicals are being used, the deciduous broadleaf species listed in Chapter II may be defoliated and/or killed.

During aerial application, based on spring spray 1977 experiences of Cameron and Anderson, it can be expected that some segments of buffer strip

will be inadvertently treated due to pilot error. In these instances some species of the riparian vegetation inside the buffer zone area will be injured or killed.

Riparian zones along the streams not designated as Class I are also important and will be subjected to herbicide applications to the extent they project into the proposed project areas.

Expected Effects of Ground Application of Herbicide on Riparian Vegetation

The proposed action requires a 25 foot (50 foot silvex) untreated buffer strip when vehicle-mounted spray equipment is used along roads that parallel class I streams. No specific buffer strip minimum width has been specified for protection of streams other than class I by this method. Therefore, it is probable that riparian zones which are valuable to the aquatic resource will be damaged by this action, especially along smaller streams. The level of damage will depend upon the amount of spray applied, time of year, the chemical, and the vegetation.

The use of vehicle mounted hand-held spray nozzles proposed for use on 1,235 acres annually has the greatest probability of damaging riparian vegetation adjacent to the roadsides being treated. This method allows long reaches (50 feet + or -) and usually employs brush killing herbicides that impact many riparian plants. The vehicle mounted fixed boom spray method will be least likely to damage the adjacent riparian vegetation in that it is used to

kill grass along road shoulders and reach about 6 feet, + or -, from the road. The grass killing herbicides do not affect most riparian plants. Dicamba and Tordon 101 cannot be used within 100 feet of any stream or water body. This reduces the probability of damaging riparian vegetation during roadside application.

Many roads have been built alongside stream bottoms that encompass the riparian zone. There usually remains an area of riparian vegetation between the road and the stream. The width is quite variable but the vegetation is usually riparian in nature. Treatment of this vegetation with herbicides reduces the nutrient cycling base of the stream which may have already lost substantial amounts during the road building process. Defoliation of hardwood brush and trees in some cases can add to thermal pollution of the stream. The open road clearing allows a sunlight path that can more easily penetrate the stream when herbicides have partially defoliated the riparian zone between the road and the stream. Loss of aquatic organisms will generally be commensurate to the amount of habitat degradation that occurs. However, there is no data available to quantify these losses.

The Effect of Hand/Back Pack Application of Herbicide on Riparian Vegetation

The proposed hand application of herbicide by back pack (5,714 acres), injection and pellets (4,179 acres) as described in the proposed action will be permitted to within 10 feet of all streams and bodies of water except for

the additional restriction on the use of dicamba, silvex and tordon. Approximately 9 miles of perennial stream and 45 miles of intermittent stream flow through the areas proposed for treatment with tordon, silvex and dicamba.

The ten foot buffer strip prescription can result in a loss of big leaf maple and red alder from the riparian zone where it extends beyond 10 feet in width. In general, big leaf maple and red alder are two of the major deciduous tree species in the riparian ecosystem of western Oregon. The proposed 1978 treatment of big leaf maple on 4,694 acres that may contain 12 miles of perennial and 45 miles of intermittent streams is planned in the action. Aquatic organisms dependent on big leaf maple and alder for life support function can be reduced in number if these trees are killed with herbicides. There is no data to quantify the expected reduction. An increase in thermal pollution on perennial streams in summer can be expected if sufficient shade loss occurs (Brown 1970). Many big leaf maple trees have a crown of a least 60 feet in width which provides abundant stream shade when they are located along streams. Nutrient cycling can also be reduced (Triska and Sedell 1976). All streams and bodies of water with adjacent riparian vegetation can be subjected to the possible retardation or killing of vegetation to within 10 feet (20 feet-silvex) of the water by this hand method using chemicals (except Dicamba and Tordon) listed in Appendix D.

Cumulative Impacts on Aquatic and Riparian Vegetation

1. Aquatic

No cumulative impacts on aquatic vegetation are anticipated from the proposed action.

2. Riparian Vegetation

The cumulative impacts of all forms of herbicide application as proposed by this action would be greatest on those riparian zones that extend outside the buffer zones designated to protect streams within proposed project areas. The 70.4 miles of Class I stream to be protected with 100 foot (200 foot silvex) buffer strips are only a portion of the total area in riparian vegetation. The subsequent riparian loss is expected to be extremely variable in distribution and unpredictable in magnitude. The duration of any loss would last until damaged vegetation recovered to its former growth level or other plants such as conifers have become dominant. The spraying of more tracts in any given drainage basin over a period of years could increase the loss or prevent recovery of specific riparian vegetation.

Aquatic Organisms

The entry of herbicides into the aquatic environment in all sub-biomes can only be viewed in a manner that places it in a negative value category.

The question that must be answered is to what degree, if any, do herbicides adversely effect aquatic life. (See Chapter I for chemicals proposed for use.) The research on the effects of herbicides on fish and other aquatic organisms listed in Chapter II demonstrates that they can be acutely toxic if concentrations enter the aquatic environment in amounts exceeding sub-lethal limits. The amount of any of the herbicides required to kill fish and other aquatic organisms listed in table 37 is variable depending upon the quantities and qualities of the water at that moment in time. Environmental factors such as acidity, hardness of water, temperature, oxygen content, flow and the nature of the ecosystem all can influence the level at which the herbicide can acutely affect aquatic life forms.

The estimated 1,075 miles of streams involved in the project areas proposed for 1978 (see treatment maps Appendix D) are all inhabited by aquatic organisms (see table 27, Chapter II). The 70.4 miles of Class I stream involved in or adjacent to the proposed project areas have important fish values for man. An additional 104.6 miles of perennial Class II streams are present that may provide some small populations of resident fish with habitat and abundant year round aquatic organism production. Those species of fish listed in table 27 as residing near spray areas are those that could to be affected by herbicide use.

Fish and Microorganisms

A review of available research literature reveals that researchers have made an intensive effort to define the effects of various herbicides on the environment. Fish and aquatic organisms have been found to be among the most sensitive life forms in their reaction to chemicals. Therefore, they have been used to research the lower lethal limits of the various herbicides. It has been impossible to test all organisms with all chemicals due to cost and time. Researchers have therefore selected sensitive fish and aquatic organisms that are judged to be representative of the various biological groups. The results of the test are then assumed to represent the entire group. The lethal concentration of each chemical that will kill 50 per cent of the group of organisms has been established by scientists as the lethal limit which is commonly expressed as an LD_{50} (Lethal Dose), LC_{50} (Lethal Concentration) or TL_m (Tolerance Limit Median). Commonly used organisms for these tests are Bluegill, Rainbow Trout, Daphnia, Largemouth Bass, Stoneflies, and various others. However, the number of organisms studied is small in relation to the many thousands in the aquatic ecosystem, each of which may have a different LD_{50}. It therefore becomes necessary to use assumed levels of toxicity for those unresearched organisms based on known data for the nearest life group and life stage. The researcher also has to make assumptions about the effect on the habitat of the organism. It is possible that the chemicals could affect the life zone of the various organisms in such a manner as to inhibit such life functions as feeding, breeding, etc., however, there have been no results that document this happening. Very little research has

been done in the wild environment due to the fact that too many uncontrolled variables exist. It must therefore be assumed that results of experiments in the laboratory will apply to the field.

It has been noted that laboratory research on the LD_{50} and sub-acute levels of various species are carried out in aquarium studies which is a glass enclosed environment. For this reason, the data obtained may not portray very accurately what will happen in a natural environment. Although the factors of circulation, absorbtion, hardness, temperature and other factors are variable throughout the natural environment and thus different from a controlled environment the aquarium studies are thought to provide a "margin of safety". Aquarium studies tend to magnify the effect of herbicides because they are not adsorbed, diluted or broken down as readily as in the wild environment. Therefore, herbicide values that occur in aquariums are thought to be much greater than those occurring or persisting in the natural ecosystem following herbicide application.

Fish and other aquatic organisms cannot escape the aquarium but may be able to move out of contaminated areas in the wild should they encounter lethal concentrations, assuming they can detect the chemical.

It has been noted that researchers have a problem with what one scientist termed an "all-or-none syndrome" (HEW, 1962). The organisms tested either live or die and if they live they are considered unaffected. A problem exists in that it is very difficult to ascertain during a research project whether

the organism may later fall prey to disease or predators because its health or habitat is slightly changed from the normal. The foremost researchers readily admit that additional work on sub-acute levels of toxicity are needed to clarify the impact on aquatic organisms. It is generally agreed the herbicide application does not lead to chronic (long-term) doses that would persist for weeks or months. Therefore the acute levels have received the most consideration. In an effort to take into account unknown factors previously mentioned, scientists have recommended that a "safety factor" for the amount of herbicide in the water not exceed standards extrapolated from the lowest toxic dose given the most sensitive aquatic organisms. The variables once again enter the scope of assumption when "safety factors" for aquatic life forms are being recommended but the research data has indicated that the following generalizations can be made about chemical impacts on aquatic organisms in the stream environment (EPA, 1977):

1. For acutely toxic material, limiting peak concentrations in streams on the basis of aquarium tests of 24 hour or more offers more margin of safety than suggested by aquarium data (EPA, 1977).

2. For any toxic material, small forest streams cleanse more rapidly. Hence, they will tolerate a given peak level of contamination more readily without major harm than will larger streams. There is therefore justification in using smaller safety factors on small streams than on large (EPA, 1977).

3. Lower maxima are appropriate for extended exposure than for short-term peaks with the same safety factors in use (EPA, 1977).

4. Concentrations change slowly in large streams, and a greater chance for chronic exposure occurs from a given concentration (EPA, 1977).

5. Large streams at elevated concentrations emit larger amounts of chemical into the next larger stream than feeder streams of the same concentration, thus creating more general pollution problems for a given level of contamination (EPA, 1977).

6. Large streams contaminated at high levels offer little escape opportunity for organisms (EPA, 1977).

7. Sustained high levels of contamination, as might be associated with pollution of larger rivers, offer maximum opportunity for biomagnification of compounds having this tendency (EPA, 1977).

These factors were taken into account when the safety factors for each chemical as they pertain to the aquatic organisms were estimated. Table 37 lists test species, the concentration causing mortality, the herbicide and the recommended maximum concentration for streams based on streams flowing less than 10 cfs which is typical for those involved in the proposed herbicide program. Safety factors were estimated at 1:5, 1:10, 1:100 by scientists

based on the toxicity of the chemical to the various organism and its likelihood of persisting in the aquatic environment (EPA, 1977).

Monitoring

The no-effect level of 0.1 ppm has seldom been found or exceeded during stream monitoring following aerial herbicide applications. This no-effect 0.1 ppm is a 10 fold margin of safety since the LD_{50} for many of the common herbicides in the laboratory is at the 1.0 ppm level. Due to the fact that the laboratory tests tend to magnify the lethal effect on the test animals, the 10 fold margin for natural aquatic ecosystems was judged by researchers to be a safe margin. The tabular presentation in table 37 indicates that most herbicides would have to exceed the 1.0 ppm contamination level in order to even approach a lethal concentration. Field results in the Coos Bay District where Silvex and 2,4-D were applied in 1977 indicated that of the eleven representative streams in the 12,253 acre project which were selected to be intensively monitored, nine were found to contain amounts of herbicide ranging from less than 0.001 ppm to 0.012 ppm of 2,4-D and less than 0.001 ppm to 0.005 ppm of silvex at some point within a 72 hour period (table 38). These streams were all protected with buffer strips (Cameron and Anderson, 1977). Researchers have found that juvenile fish are more sensitive to chemicals than adults and egg stages are more resistant to chemicals than the juvenile stages. Some researchers have found eggs to be about 3 to 10 times more resistant than fry in the 1/2 to 1 1/2 gram swim-up stage (Woodard 1977). Norris (1974) found in studies concerned with the toxity of TCDD in guppies

Table 37 Effects of Common Forest Herbicides on Aquatic Organisms and Recommended Maximum Concentrations

Compound	Test Organism	Dose in ppm/Effect	Stream Concentration Recommended Maximum	Reference
2,4-D	Bluegill	3.0/48hr. LC_{50}	0.03 ppm	OSU/EPA 1977
" Dimethylamine	Bluegill	166-458/48hr. LC_{50}		Lawrence 1969
" Isooctyl Ester	Bluegill	8.8-59.7/48hr. LC_{50}		Lawrence 1969
" Butyl Ester	Bluegill	1.3/48hr. LC_{50}		Lawrence 1969
" Isopropyl Ester	Bluegill	1.1/48hr. LC_{50}		Lawrence 1969
TCDD (Dioxin)	Coho Salmon	No effect 96hr. .000000056 mg/l	.000000006	OSU/EPA 1977
2.4,5-TP Silvex	Chinook	1.2/48hr. LC_{50}	0.01 ppm	OSU/EPA 1977
" PGBE Ester	Bluegill	25.0/48hr. TL_m		Hughes & Davis 1966
" PGBE Ester	Fish (saltw.)	0.36/48hr. TL_m		Butler 1965
" Butoxyethonal	Bluegill	2.0/48hr. TL_m		Hughes & Davis 1966
" Triethylamine	Bluegill	20.0/48hr. TL_m		Hughes & Davis 1966
" Isooctyl Ester	Bluegill	5.0/48hr. TL_m		Hughes & Davis 1966
Atrazine	Crustacean	1-10/48hr. TL_m	0.1 ppm	Thut & Haydu 1971
	Fish	1-10/48hr. TL_m		Thut & Haydu 1971
(Triazines)	Daphnia	1/48hr. LC_{50}	(triazines)	OSU/EPA
Diuron (Karmex)	Fish	5-15 LC_{50}	----	Juntunen & Norris 1972
Dicamba	Bluegill	23/96hr. LC_{50}	0.004 ppm	OSU/EPA 1977
Dicamba	Rainbow Trout	35/24-48hr. LC_{50}		Velsicol 1974
Dicamba	Rainbow Trout	28/96hr. LC_{50}		Velsicol 1974
Dicamba	Bluegill	130/24hr. LC_{50}		Velsicol 1974
Dicamba	Bluegill	23/96hr. LC_{50}		Velsicol 1974

Table 37 (Cont'd) Effects of Common Forest Herbicides on Aquatic Organisms and Recommended Maximum Concentrations

Compound	Test Organism	Dose in ppm/Effect	Stream Concentration Recommended Maximum	Reference	
Krenite	Bluegill	670/LC_{50}	5.0 ppm	OSU/EPA	1977
Krenite	Rainbow Trout	1000/LC_{50}		DuPont	1977
Krenite	Fathead Minnow	1000/LC_{50}		DuPont	1977
Picloram (Tordon)	Lg. M. Bass	19.7/48hr.LC_{50}	0.5 ppm	OSU/EPA	1977
	Fish	13-90/TL_m		Norris	1971
	Other Aquatics	1.0+/TL_m		Norris	1971
	Fish	10-100/TL_m		Thut & Haydu	1971
	Crustaceans	10-100/TL_m		Thut & Haydu	1971
	Aquatic Insects	10-100/TL_m		Thut & Haydu	1971
Dalapon (Dowpon)	Daphnia	11/48 hr.LC_{50}	0.1 ppm	OSU/EPA	1977
Dalapon (Dowpon)	Bluegill	115/24-48hr.LC_{50}		Cope	1965
Dalapon (Dowpon)	Bluegill	105/96hr.LC_{50}		Cope	1965
Amitrole	Bluegill	670/48hr.LC_{50}	5.0 ppm	OSU/EPA	1977
Amitrole-T	Bluegill	100/48hr.TL_m		Sanders	1970
Amitrole	Coho Salmon	325/48hr.LD_{50}		Norris	
Triazines	Daphnia	1.0/48hr.LC_{50}	0.1 ppm	OSU/EPA	1977
Simazine	Bottom Org.	28/LD_{50}		Walker	1964
(triazine)	Sunfish 3sp.	35/LD_{50}		Walker	1964

Table 38

Results of Analysis of Water Samples Taken From Selected Streams During FY 1977 BLM Spray Project 5/

Stream Name & (Station)	Herbicide (ppb)	Time Intervals (hrs. after spraying) 0.0*	0.5	2.0	5.0	24.0	72.0
Russell Creek	2,4-D				0.0		2.2
	Silvex				0.0		2.2
Russell Cr. Trib.	2,4-D			5.0	3.6	<1.0 4/	12.0 6/
	Silvex			2.0	2.4	1.0	5.0
Endicott Creek	2,4-D	0.0 3/		2.0	5.0 6/	1.0	
	Silvex	0.0		1.3	2.5	2.0	
Johns Creek 1/	2,4-D			<1.0	<1.0	1.6	0.0
	Silvex			<1.0	<1.0	1.6	0.0
S. Fk. Elk Cr.	2,4-D			<1.0			
	Silvex			<1.0			
Buck Creek (3)	2,4-D			<1.0	0.0		
Composite of "A" & "B"	Silvex			<1.0	0.0		
Buck Creek (1)	2,4-D			0.0	0.0		
A	Silvex			0.0	0.0		
Cox Creek	2,4-D			<1.0	0.0	0.0	
	Silvex			<1.0	<1.0	0.0	
Carpenter Cr.	2,4-D		<1.0	<1.0	1.7	<1.0	<1.0
	Silvex		<1.0	<1.0	<1.0	<1.0	1.0
Vincent Creek	2,4-D	0.0	1.4	<1.0	<1.0	0.0	
	Silvex	0.0	1.5	<1.0	<1.0	0.0	
Mine Creek 2/	2,4-D			0.0			
	Silvex			0.0			

* Control sample taken prior to spraying.

1/ Johns Creek sampling scheme - 1, 13, 19, and 72 hours after spraying was completed

2/ No cards set out.

3/ The values of 0.0 ppb indicate that no herbicide residues were found in the water samples (Wehr, 1977).

4/ The values of 1.0 ppb indicate that herbicide residues were definitely detected, but the amounts found were below the limits of reliability of the instrument being used for analysis, i.e., there are amounts present which are difficult to quantitatively establish and are, therefore recorded as something less than 1.0 ppb not to include 0.0 ppb (Wehr, 1977).

5/ Cameron and Anderson, 1977.

6/ The concentration of herbicide increased following heavy rain.

(Poecilia reticulatus Peters), that organisms increase their tolerance to environmental stress with increasing age and body mass. Also smaller fish were more sensitive than larger ones, not only to TCDD but to several other toxicants. Furthermore, fish have been found to be more resistant to the effects of herbicide than aquatic invertebrates (Kimmins, 1975 and Norris, 1971) and as a result, the no-effect-levels for aquatic invertebrates may be much lower than those indicated for fish. Unfortunately most of the literature does not specify how large the fish species were or at what stage of development they were tested. In many of these cases it is necessary to assume that the "safety factor" established for each herbicide will be adequate to protect all life stages. Other delicate aquatic invertebrates tested may provide adequate indication that lethal limits are far higher than fry or alevins would ever experience in the natural environment when herbicide is not applied directly to the water.

TCDD in the Aquatic Environment

The effects of TCDD (Dioxin) on aquatic animals has been tested in laboratories and was shown to be extremely toxic (Miller, Norris & Hawkes, 1973). Concentrated doses used in the laboratory to kill fish have not been observed in the normal field use of the chemical, Silvex.

A serious question presently exists concerning the effect of minute quantities of TCDD on organisms and its bioaccumulation. TCDD was accumulated from water by fish in laboratory studies (Kearnery, 1976). Bioaccumulations

of TCDD were found in algae, snails and fish but not in some other animals such as sea lions, eagles, herring gulls and butterfish (CAST, 1975). Mutsamura and Benezet (1973) found that under laboratory conditions TCDD in the water and on a sand substrate could be picked up by brine shrimp through absorption. However, other researchers thought these findings could have been impurities in the carbon 14 labeled TCDD used in the test or by photo-degradation products other than TCDD.

This disagreement and lack of information concerning TCDD has prompted EPA to conduct studies on bioaccumulation which are currently in progress as directed by an EPA Dioxin monitoring committee.

Expected Effects of Aerial Herbicide Application on the Aquatic Organisms

The maximum stream contamination found by researchers coupled with field water samples from recent BLM projects (Cameron and Anderson 1977) suggests that the possibility of exceeding the recommended maxima (EPA 1977) are small (aquatic organisms should be unharmed if these levels are not exceeded). This statement is based upon the premise that application is controlled and adequate buffer strips will be left along all flowing streams, bodies of water and marshes. However, only 70.4 miles of the 1,075 miles are required to have buffer strips of 100 feet or more in this action. Although the buffer strips are not the actual deterrent to the herbicide contaminating the stream, they do provide a "no application zone" which reduces contamination. It is possible to apply chemicals up to the stream edge without contaminating water (EPA,

1977). However, the irregularity of terrain, stream courses, and physical features makes it almost impossible to accomplish by aerial means.

Even with the leaving of buffer strips it is known that there will be some chemicals that inevitably enter the stream. It was found that wider bufferstrips along streams (i.e., 200 feet vs 100 feet) resulted in less chemical contamination of stream water (EPA, 1977). Experience in the Bureau's Coos Bay District indicates that chemical entry may happen due to planning error, pilot error, drift and washing of chemical into the stream by rain following spraying (Cameron and Anderson, 1977).

Cameron and Anderson reported that in the Coos Bay District BLM spring spray program, the contamination which occurred in most of the Class I streams that were monitored seemed to be a result of overspray into Class I streams, or direct hits on Class II tributaries even though all were buffered. The main reason for these hits was assumed for the most part to be due to pilot error or inability of the pilot to maneuver in small units. Some of the areas had spray units that were clearly marked along the boundaries and stationed personnel in or near the units to insure that the possibilities of overspraying the units were reduced. Reconnaissance flights were made to familiarize the pilot with the unit and to point out buffer strips and other areas that were to be avoided. This procedure was carried out in all of the areas and with all of the pilots. However, with all precautions that were taken, some contamination of stream systems and buffer strips still occurred.

The winter and spring application of bud break herbicide in the deciduous brushfields will provide greater chance of stream contamination than the summer applications. Spring spray projects occur when streams are highest and buds are bursting, but leaves have not fully canopied out to intercept the spray. The streams are generally flowing large quantities of water and thus provide a greater interception area. The impact on the aquatic organisms would be assumed to be less than in the summertime because the rate of dilution would be relatively rapid. However the situation for evergreen brushfields is expected to differ. The evergreen shrubs provide greater herbicide interception than do deciduous brush due to the full canopy. This interception should substantially reduce the amount of water contamination that can be anticipated in those areas during application of aerial herbicide.

The summer spray would allow less herbicide to reach the forest floor due to the full canopy available to intercept it. The streams will be at their very lowest and therefore, provide very little target area. Very little rain usually can be expected at that time of year; therefore, almost no washing of chemicals into the streams would be expected. If the program extends into September, rain can be expected. However, any chemical that did enter the stream would be likely to last longer due to the extreme low flow. With the exception of major water courses, most streams associated with herbicides will be likely to carry a flow of less than 1/2 cfs and many will be less than 1/4 cfs. This could reduce turbulence and dilution substantially, thus increasing chemical duration and toxic effects on aquatic organisms. Many aquatic organisms and fish are trapped in small pools during this summer low water

period. Any application of herbicide that reached these pools is potentially more damaging due to lack of flow.

If streams, bodies of water and marshes are not protected and all or part of the riparian zones and the water is aerially sprayed, contamination of water could potentially 1) exceed EPA 1977 stream maxima recommendations and 2) approach or exceed lethal dose concentrations for short periods of time for some fishes. This is based on analysis of LD_{50} rates of 1000 ppb for bluegills and contamination found by Norris 1975 in an unbuffered marshy stream where 2-4-D levels reached 840 ppb. This data leads to the conclusion that if 1000 ppb for 48 hours will kill 50 percent of the adult bluegills in the test, 840 ppb for a lesser duration may kill salmonid alevins or other small aquatic organisms considering that Norris found that body mass influenced survival (i.e. larger fishes survived better). The highest possibility of contamination at toxic levels would occur during the spring or winter application due to increased flow and limited foliage to intercept the herbicide.

The treatment of water and riparian zones with herbicides is expected to reduce aquatic nutrient cycling (Triska and Sedell 1976), increase thermal pollution (Brown 1970) and thus reduce the amount of coldwater fish habitat (Lantz 1971). Table 37 indicates that winter and spring spray of 2,4-D and Silvex and possibly other herbicides applied directly to water surfaces could result in the death of small salmon and steelhead in sac, fry and swim-up stages. These fish will be emerging from gravel beds at that life stage most sensitive to these chemicals (Woodard 1977) (Miller, Norris and Hawkes 1973).

The duration of pollution will be on a declining scale with a peak less than one hour after treatment to a point ten days later where the chemical usually becomes undetectable (Norris 1975).

Expected Effects of Ground Application Methods

The proposed action will require a 25 foot (50 foot-silvex) untreated buffer strip when vehicle mounted spray equipment is used in the treatment of some 1,825 acres along roads. The probability of water contamination will depend upon the care of application by the operator. If best practices are carried out, no water will be contaminated by these methods. However the use of hand held spray nozzles proposed to treat 1,235 acres has a possibility of reaching water areas adjacent to the roadsides being treated. The fixed boom spray method will be least likely to contaminate water unless ditch water is contacted. If ditch water is contacted it is possible that this could result in contamination of larger bodies of water. Dicamba and Tordon are restricted from use within 100 feet of a stream or body of water but it may be possible for these water soluble chemicals to enter important bodies of water and exceed the EPA 1977 recommended maximum of .004 ppm. The impact of these chemicals on aquatic life will depend upon the concentration as shown in table 36.

Expected Effects of Hand Application on Aquatic Organisms

The impact of hand injection methods on water quality and aquatic organisms is expected to be negligible or none at all. The use of back pack sprayers to apply herbicide to specific plants should also prevent contamination of water when conducted with reasonable care. Hand application of herbicide pellets to the base of trees should pose little hazard if water is avoided and the pellets do not dissolve and enter the stream through ground water flows.

Cumulative Impacts on Aquatic Organisms

A direct (lethal dose) cumulative impact on aquatic organisms is not expected to occur when herbicides are applied as described in Chapter I. The short duration and low level of contamination previously discussed indicate no effect will be measured even at the time of application. The short life span of the chemical in the environment (table 31) also appears to preclude any cumulative impact.

Cumulative indirect effects on aquatic organisms may occur through a loss of habitat needed by fish and other aquatic organisms. The size of habitat loss previously discussed in the aquatic vegetation portion of chapter III indicates the magnitude of the impact is unknown. The extreme variability in treatment impacts on each segment of riparian vegetation makes prediction impractical. The only definable parameter will be the 1,075 miles of stream

and related riparian habitat in the area that will have a potential for indirect impact.

The Bureau is currently in the process of developing guidelines for riparian zone management that affect aquatic organisms.

Conclusions

Conclusions Concerning Impacts on Aquatic Plants, Riparian Vegetation, Aquatic Organisms and the Aquatic Ecosystem from the Application of Herbicide as Described in the Proposed Action.

Aquatic Plants

1. Hand and back pack methods have little potential for contamination of water and hence affecting aquatic plants in 1,075 miles of stream involved in the proposed action.

2. Only long term, high-level exposure measurably affects aquatic plants and this is not expected to occur during the use of forest herbicide as proposed in this action.

Riparian Vegetation

1. Vegetation within the 100-foot (200 foot-silvex) buffer strip to be left during aerial application on class I streams will receive some drift and this will, in some cases, retard the growth of some riparian vegetation along 70.4 miles of class I streams involved in the 1978 proposals.

2. Herbicide applied by truck-mounted methods to within 25 feet (50 feet-silvex) of streams can heavily reduce vegetative growth in riparian zones by eliminating or damaging major hardwood components.

3. Hand application of herbicide to within 10 feet of the stream is expected to heavily damage big leaf maple in the riparian zone along the 57 miles of stream that may potentially be involved.

4. Riparian zones along the 1,075 miles of stream could be cumulatively impacted through damage and killing of vegetation either through repeated application to the same location or locations adjacent to each other over a period of years.

5. The use of herbicides in the riparian zone that extends into proposed treatment areas along 1,075 miles of stream can be expected to have an adverse effect on the aquatic ecosystem because they affect hardwood species that are a major component of the riparian zone.

6. Riparian zone management policies do not presently exist but are being studied by the BLM and other agencies because research only recently pointed out the value of these zones to the ecosystem as a whole.

Aquatic Organisms

1. Although herbicides are toxic to fish and aquatic organisms, there is very little possibility the application will reach the lethal concentration level in streams or bodies of water when adequate buffer strips are left.

2. There is relative certainty that some herbicides will enter the water during application, but the duration of detectable levels will not in most cases last more than a few hours to ten days.

3. The width of stream buffer strips will influence the amount of herbicide that enters the stream, i.e., the wider the buffer strip the less probability of herbicide entering the stream system and the smaller the quantity.

4. The use of hand applied herbicide poses little possibility of any water contamination or damage to aquatic life but the damage to big leaf maple in the riparian zone may reduce stream production of aquatic organisms by raising water temperatures and reducing habitat and nutrient cycling.

5. The application of herbicide of all kinds in the winter and spring to approximately 61,526 acres annually containing approximately 740 miles of flowing stream when wet weather prevails, will provide a greater chance for chemicals to enter the water and contact aquatic life than during the dry season when 12,891 acres containing 32 miles of flowing stream is proposed for treatment. (Refer to Appendix D for location, timing, and chemicals to be used.)

6. The use of dicamba and tordon along roadsides in wet weather poses the greatest possibility of exceeding established standards due to their water solubility and proximity to drainages intersected by road ditch lines. The effect on aquatic organisms will depend on the concentrations reaching their habitat. The likelihood of lethal concentrations being reached appear to be small when proper precautions are used. (Refer to table 37 to find lethal concentrations for aquatic organisms.)

Aquatic Ecosystem

1. The single most important impact to the aquatic ecosystem from herbicide application will be caused by habitat destruction both immediate and cumulative when riparian vegetation which is susceptible to spraying along the 1,075 miles of drainways (shown on maps in Appendix D) is treated with herbicides that impact riparian vegetation. The loss of any of this riparian habitat will result in a subsequent loss or change in composition of the population of aquatic organisms.

WATER QUANTITY AND QUALITY

There are approximately 1,075 stream miles (Westside Water Study, 1976) in or adjacent to the 74,436 acres of proposed treatment area where water quantity and quality could be impacted by direct application of herbicides on the water surface, treatment of adjacent riparian zone vegetation or by rapid overland flow of water from roads or other compacted areas.

All the herbicides listed in the proposed action could have short-term impacts on water quantity and quality to some extent. The herbicides are proposed to be used with selected seasonal, wind and other controls that minimize the possibilities for water contamination. These project design features are described in detail in Chapter I. There would be approximately 185 miles of streams, (Westside Water Study, 1976), about 17 per cent of the total, flowing in the proposed treatment areas during herbicide application periods and conditions stated in the proposed action.

Potential impacts of herbicides on water quantity and water quality are identified and described in the following discussion. Sufficient data is not available to subdivide the analysis by the two areas described in Chapter II.

Water Quantity

The change in vegetation that will result from the proposed action as described in Chapter I should have little impact on water yield. The death or injury of the target forage would reduce the transpiration of these target species. Most target species will be injured rather than killed. The injured root structure would stay intact but consume less water. Forage litter on the forest floor would aid in evaporation retardation and reduce erosion by rain splash. During the dormant months (low consumptive use) of the deciduous target species, precipitation is high (more than 8 inches per month on the average) which exceeds the consumptive use of vegetation including the conifers. During the drier months of May through September which average from nearly 0 to 4 inches per month the conifers would transpire more water if competition from the no longer dormant target species was less because of herbicide impacts.

Subsurface flow should on the average remain unchanged except following rain storms that cause increased surface runoff during the dry months. The increased surface runoff would be water that exceeds consumptive use.

There could be a minor increase in overland flow of water entering streams. However, overland flow is quite uncommon in western Oregon. The ratio of overland flow to streams is small and amounts to a few percent. Localized flows as a result of herbicide use in the overall basin yield would be negligible.

No detectable change in irrigation water quantity would be caused by the proposed action. The use of herbicides will reduce or stop transpiration of the target species, thus would allow more water to be consumed by the conifers and greater loss to evaporation. Essentially the water quantity gain would equal the loss.

Subsurface runoff from the proposed treatment areas could increase as a result of treatment. This could result from rain storm periods that occur during the drier lower flow months. The decrease in vegetative consumptive use allows soil moisture to remain higher and more rainfall can be translated into streamflow. By winter, however, when soil moisture in a treated area has been recharged, the area responds nearly the same hydrologically as it did before treatment. Subsurface flow of water in western Oregon is the primary mechanism by which water is transmitted from the soil surface to streams (interpreted from Harr, 1976).

Water in ponds, reservoirs and wetlands that are downstream from proposed treatment areas could increase slightly in volume during the drier summer months. The volume increase would depend on the intensity and duration of the rainstorms increasing streamflow to them and the amount of area treated in the watershed. These increased volumes generally will be small but not determinable without major studies. Water yield would increase in increments after spraying portions of different areas. The water yield increments would be gradual and the total increase in water yield would be only a few per cent. The injured plants would recover a few years after spraying or conifers will

flourish, thus increasing consumption and reducing or eliminating increased water yield resulting from herbicide use.

Cumulative Impacts

1. Some increase in water yield in water bodies during the summer months might occur (a few percent) as a result of herbicide applications in tributary watersheds. The amount would increase in proportion to the cumulative area treated in the pertinent watershed.

Conclusions

1. A small but unquantifiable increase in water yield for instream flow and storage need during drier low-flow months.

2. No evidence that herbicides applied at the proposed rates will have adverse effects on water quantity.

Water Quality

Herbicides are mobile in soil. However, in absolute terms their mobility in soil is quite limited. Limited leaching which does occur results in a sharply decreasing concentration in the soil profile with increasing depth. In terms of the distances involved from treated areas to streams, the leaching distance for virtually all herbicides in forest soil is minor.

Forest stream monitoring for several herbicides over extended periods of time has consistently shown that leaching of herbicides in forest soils in Oregon have not resulted in detectable (less than 0.001 ppm) concentrations of herbicide in forest streams (Abrahamson and Norris, 1976).

Most of the following information and discussion of the specific herbicides was taken from the U.S. Forest Service Final Herbicide ES for Region 6, 1978.

Herbicide entry into forest streams may occur through three possible routes: (1) Subsurface water flow or leaching; (2) overland flow; and (3) direct application and drift. As discussed in the preceding section, leaching is a relatively slow process which is unlikely to contribute significant residues to forest streams.

Abrahamson and Norris, 1976, have discussed herbicide entry further.

Overland Flow

Overland flow of herbicides can occur only if overland flow of water occurs. Hydrologists report that overland flow of water is extraordinarily uncommon on nearly all forest lands. The infiltration capacity of forest lands far exceeds intense rates of precipitation. There are compacted areas, such as roads, skid trails, and landings where some localized overland flow can occur. These areas, where soil is compacted

or bare of vegetation, are scattered and can usually be avoided during application. Field testing on forest lands has verified that overland flow of herbicide is restricted to localized events involving bare, compacted, or water repellent soils and litter immediately adjacent to streams and that the overland flow has shown marked reduction in herbicide concentration in water as it moves over uncontaminated soil that adsorbs the chemicals.

Direct Application and Drift

Direct application and drift of spray materials are the principal routes of entry to forest streams. This is a physical process, which can be markedly influenced by man. Herbicide concentrations in forest streams which are in or adjacent to treated areas range from nondetectable limits (less than 0.001 ppm), to a maximum of 1 ppm, with more than 99 percent of all values less than .01 ppm even when no particular effort is made to avoid direct application to stream surface with either ground or aerial application methods. Research has shown that the location of forest treatment units with a buffer strip along the streams reduced herbicide concentrations in streams to less than 0.01 ppm with residues detected for less than 1 day after application.

These measurements were made immediately downstream from treatment unit boundaries and, therefore, represent maximum concentrations in the stream system. Monitoring results from the mainstem of major streams are

described in Chapter II. They show virtually no detectable level of herbicides. Extensive monitoring of present-day operational applications of herbicide in forests show most applications do not result in significant concentrations of herbicide in nearby streams (see Coos Bay district experience as described in the aquatics section of Chapter II). Improved formulations, equipment, application technology, coupled with an increasing awareness of the forest manager's opportunity to prevent stream contamination with herbicides are the reasons for these almost non-detectable contamination levels.

Earlier reports of laboratory data (Kearny 1976b) indicated that pure TCDD on soil surfaces could not be degraded by sunlight. Crosby and Wong (1977) have demonstrated that TCDD, as it actually occurs in formulated herbicide products, is rapidly degraded (about 15% in six hours) on the soil surface by the action of sunlight.

In five soils with widely varying characteristics, TCDD was found to be immobile, even when subjected to leaching (Helling 1973). The possibility of TCDD entering ground water is remote (Tschirley 1971).

TCDD is nearly insoluble in water - 0.2 ppb (Dow Chemical Company 1970). For this reason, it would be expected to remain on the surface of plants and soil at the application site. Previously cited references indicate that TCDD does not leach in soils. Because it is immobile in soils, Kearney et al. (1973) concluded there would be "no ground water contamination problems." In

the natural environment, any TCDD would be expected to be found associated with other constituents of the formulation which are less soluble in water. They would form a thin film on water surfaces. Such films are expected to be degraded by sunlight, much like thin films on vegetation or the soil surface. Residues might, therefore, be substantially less than would be indicated from research with pure laboratory systems, suggesting that TCDD would be only slowly degraded in water.

Little specific information on residues of silvex in a forest environment is available. However, silvex itself is less toxic than 2,4,5-T. Both are closely related compounds and both contain the contaminant TCDD. The behavior in the environment would be expected to be very similar to 2,4,5-T.

Bailey et al (1970) studied the movement and persistence of silvex in water and sediment under impounded conditions. Application of the PGBE ester of silvex was made at the rate of 9 kg/ha. Samples were taken 4, 12, 24, and 48 hours after treatment and analyzed for the presence of the PGBE ester of silvex. Although the concentration of silvex initially increased in water, by the end of three weeks the concentration had decreased to zero. Silvex and the PGBE ester of silvex can apparently be adsorbed by sediment particles. However, there was "essentially complete disappearance" of both at the end of five weeks. A 9 kg/ha dosage is a considerably greater dosage than would be applied to a forest site or than would be expected to enter a forest stream (based on a conversion rate of 1 lb/acre = 1.12 kg/ha, and the usual application rate of 2-4 lbs silvex per acre).

Norris (1967) analyzed four 2,4-D treatment areas representing watersheds with different hydrologic characteristics. Streams within the watersheds were sampled for 2,4-D residues at various locations and points in time following application of two to three pounds per acre 2,4-D. Norris was able to calculate the level of water intake that could be tolerated by a 150-pound person. Assuming that a person would respond in proportion to size the same way as a laboratory test animal (rat) would, and that a level of 100 times lower than the LD_{50} would not produce any noticeable effect on a person, the individual would need to drink 671 gallons of water containing 2,4-D at 100 ppb to ingest 1/100 of the hypothetical LD_{50}. Norris concludes:

> "It is clear from the calculated values...that man can tolerate the concentrations of herbicides in the water which resulted from the chemical brush control projects monitored in these studies. A similar comparison for chronic exposure to low levels is probably not possible.
>
> Of greater interest would be an expression of biologically safe level of herbicide. This is defined as that concentration of herbicide which could be tolerated for extended periods of time by nearly all members of the food chain with little or no apparent damage. On the basis of the data...and on the experience of the Ohio River Sanitation Commission, this level might be conservatively set at 100 parts per billion for the herbicides investigated in this program (Bond et al 1959)."

Dalapon breaks down rapidly in soil, hydrolyzes slowly in water, but is persistent in plants. Thiegs (1955) showed that the breakdown of dalapon in soils is due to micro-biological action. Dalapon was found to decompose most rapidly in warm, moist soils, whereas in cool or dry soils the herbicide remained for extended periods.

Dalapon is apparently more persistent in water than in soil. Oxygen levels are lower and microbial populations are therefore different. Anaerobic species are favored in aquatic environments, whereas aerobes usually predominate in agriculture soils, particularly in the surface-soil layers. Most microorganisms that effectively decompose herbicides are aerobic (National Academy of Sciences 1968). Warren (1964) reports that dalapon will hydrolize slowly depending upon temperature unless some microorganisms are present.

Frank, Demint, and Comes (1970) provide data concerning the concentration and persistence of dalapon in irrigation water following tests on canal-bank treatments for weed control. On the canal where dalapon was sprayed directly on the water surface to provide a concentration of 100 ppb at the application site, it was calculated that the residue level would approach zero 20 miles downstream.

Frank, Demint, and Comes (1970) concluded that dissipation of freely water-soluble herbicides, not extensively absorbed from water solutions is affected principally by dilution. They also concluded that it is unlikely that illegal residues would be contained in crops irrigated with water containing the concentration of dalapon found in their study.

Dicamba is relatively easy to leach from surface layers of soil. Comparatively, dicamba is considered one of the most mobile of the herbicides after it enters the soil (Velsicol Chemical Corporation 1971).

Studies by Velsicol Chemical Corporation (1971) found that dicamba was rapidly broken down or leached to deeper layers of soil. There is some evidence that dicamba may be broken down by photodecomposition (Velsicol Development Newsletter Vol. #2).

Norris and Montgomery (1975) state that dicamba is one of the most mobile herbicides in soil. They add that entry into the soil profile reduces the probability of the herbicide entering streams by overland flow except during the first intensive storms after application.

Evidence obtained from stream monitoring, following an application of dicamba, leads Norris and Montgomery (1975) to conclude that dicamba posed no acute hazard to aquatic organisms or to downstream water users, and the short persistence of the herbicide in the water precluded chronic exposure. They stated that dicamba can be used for brush control on forest lands with little or no impact on aquatic environment, if direct application to surface waters is minimized by using appropriate spray application techniques.

Since the dimethylamine salt of the acid of dicamba is quite soluble in water, photodecomposition might be one of the few ways breakdown occurs in water. Uptake by stream or pond vegetation and ultimate metabolism by the

plants would also contribute to clearing water of the chemical. Precautions should be taken to avoid contamination of waterways, ponds, or lakes (Velsicol Chemical Corporation, 1971).

Kozlowski and Kuntz (1963) found that:

> When Plainfield sand to which atrazine, simazine, or propazine was surface-applied and leached, most of the herbicide remained in the first inch of soil regardless of whether two, four, or eight inches of water was used in leaching. However, some herbicides, especially atrazine, moved downward to a six inch depth. With increased amount of leaching more herbicide was translocated out of the first inch of atrazine-treated soil. Such an effect was not as apparent with simazine- or propazine-treated soil. The greater leachability of atrazine was probably related to its greater solubility. This study, which demonstrates the difficulty of removing triazine herbicides from upper soil levels even with large amounts of water, emphasizes the dangers of possible persistence and accumulation of triazine herbicides in forest nurseries, even in light sandy soils.

Atrazine is more readily adsorbed on muck or clay soils than on soils of low clay and organic matter content. The downward movement of leaching is limited by its adsorption to certain soil constituents. Adsorption is not irreversible and desorption often occurs readily, depending on temperature, moisture, pH, etc. Atrazine is not normally found below the upper foot of soil in detectable quantities, even after years of continuous use.

The residual activity of atrazine in soil at selective rates for specific soil types is such that most rotational crops can be planted one year after applications, except under an arid or semi-arid climate.

Atrazine will persist longer under dry and cold conditions or conditions not conducive to maximum chemical or biological activity. Broadcast rates needed in some of the heavier organic soils of the North Central states results in enough residue carryover, under some conditions, to injure small grains, alfalfa, and soybeans planted 12 months later. Plant removal and chemical alteration are also factors in dissipation.

Norris et al (1976a) studied the leaching and persistence of tordon (picloram) on powerline rights-of-way in the Pacific Northwest. The herbicides showed a rapid decline in concentration in forest floor and soil after application. Biologically significant residues were seldom present for more than 12 months after application. There was no leaching of herbicide below 30 cm in the soil and relatively little below 15 cm. When a forest floor was present, nearly all the detectable herbicide was present there.

Norris et al (1976b) reported tordon applied to a southern Oregon hillside pasture was largely confined to the surface six inches of soil and the concentration declined rapidly with time after application. Residues in the surface six inches averaged 60, 20, and 4 ppb picloram 9, 18, and 27 months, respectively, after treatment.

Norris et al (1976a) reported no residue of tordon was found (minimum detectable level 0.1 ppb) in streams flowing accross treated powerline rights-of-way despite intensive sampling with automatic equipment for periods in excess of six months after application. The authors conclude the lack of residues in stream water is consistent with the relatively short persistence and limited mobility of tordon in the environment.

Norris (1969) noted that in an area where 67 percent of a watershed was sprayed in August, residues up to a maximum of 0.078 ppm were detected after the initial one inch storm and they decreased thereafter. No residues were found after late October or where only a small portion of the watershed was treated.

Norris et al (1976b) studied tordon outflow from a 16-acre hillside pasture watershed in southern Oregon. The entire watershed was sprayed with two pounds per acre tordon, including the dry stream channel. There was no water in the stream until October. The first two storms caused limited wetting of the stream channel and filled the pools but caused no outflow from this gauged watershed. Maximum tordon concentration was about 0.1 ppm. The first water to flow from the watershed carried some tordon, but the concentration was low (20 ppb). No herbicide was detected after January.

About 0.28 percent of the tordon applied to the watershed appeared in streamflow during the three year study. The dry stream channel accounts for 0.21 percent of the area of the watershed. The authors concluded the

herbicide outflow largely represented mobilization of residues applied in and near the dry stream channel.

Simazine has little lateral movement in soil but can be washed along with soil particles. Leaching is limited by its low water solubility and adsorption to certain soil constitutents. It is more readily adsorbed on muck and clay soils than in soils low in clay and organic matter (Weed Science Society of America 1974).

The low to moderate mobility of S-triazines (of which simazine is one) reduces the possibility of contamination by vertical leaching to ground water. Surface movement is somewhat more likely on steep slopes when intense rainfall occurs immediately after application (Helling 1970).

Krenite is soluble in water but readily absorbed by soil particles. Therefore, it does not have the potential to run off into surface waters or leach into subterranian aquifers. It has a Freundlick K equilibrium constant on Keypart silt loam greater than 20, indicating a high absorbtion to the soil (Du Pont 1976).

The descriptions of the following herbicides were taken from the Oregon Weed Control Handbook, 1978.

Diuron is a white, crystalline solid having a melting point of I90 C. Although it is soluble in organic solvents such as acetone and alcohol,

the chemical has the relatively low water solubility of 42 ppm. Diuron is extensively adsorbed on soil constituents, particularly organic matter. The low water solubility and adsorption properties result in slow leachability, so that appreciable precipitation is required to move the chemical into the root zone of germinating weeds. There will be insignificant volatility losses of diuron since it has a very low vapor pressure. Although diuron is broken down by microorganisms, the rate of decomposition is much slower than with other organic herbicides. Thus the chemical tends to persist from one growing season to the next. This property can be very important when the chemical is used in the same area in successive years.

Round Up (Glyphosate) is a white solid having a water solubility of 10,000 ppm. The compound has negligible volatility. Round Up is rapidly inactivated upon contact with soil, so that there is little or no residual activity. It appears to be well translocated to roots following foliar absorption. Since it is quite water soluble, and inactive in the soil, precipitation soon after application will greatly reduce its effectiveness.

Herbicides have little chance of reaching ground-water aquifers because of rapid degradation and resistance to leaching. Only water tables a few feet below the land surface would have detectable effects on groundwater in storage and little chance of being present in detectable amounts in water when discharged by wells. Detectable concentrations of persistent herbicides may be present in areas of high water tables such as marshes if herbicides are applied on or adjacent to them.

Phenoxy chemicals entering water may be lost by volatilization, adsorption by biota, by degradation, and by dilution as additional stream flow passes through the site. This latter function is by far the most important. Almost all authorities agree that there is adsorption on bottom sediments (Bailey et al, 1970) (Frank and Comes, 1967). This contamination of botton sediments, however, does not appear to last long. Concentrations of low volatile esters of silvex in water after application on the surface of three ponds decreased to nondetectable limits by the end of three weeks (Bailey et al, 1970).

Only small amounts of herbicide will probably enter streams by washing action of rain from overhanging treated vegetation above a stream or from leaves falling into water (Norris, et al, 1970). Observations indicate that heavy fall rains will not leach detectable amounts of Phenoxy herbicides through the soil into streams if the herbicides have been applied during the spring or very early summer. The phenoxy herbicides move through the soil only in very small amounts and for very short distances. There seems very little chance of stream pollution from this source (Norris and Moore, 1970). Although small amounts of phenoxy herbicides are from roots of treated plants, this also is a negligible source of contamination.

A field test was carried out in a fast-flowing stream which provided maximal opportunity for dilution and interchange of water. Residues of silvex were not detected except during the first few hours following treatment. The maximum level found in this study was 0.05 ppm (Frank et al, 1970).

Erosion could transport these herbicides in soil particles to water courses, especially if the erosion occurs immediately after application.

In irrigation practices, such as in the Willamette Valley, the tail water may contain large concentrations of undesirable chemicals including insecticides, herbicides and fertilizer. Whenever water from return irrigation is used for domestic purposes, a periodic chemical analysis should be made. Because of poor quality this water should be used only if no other water source is available (EPA-430/9-74-007, 1974).

Concentrations of 2,4-D were determined in irrigation water following ditch bank applications for weed control.. Applications of 1.9 to 3 lb/A of 2,4-D produced maximum concentrations of .025 to .061 ppm. Reduction of herbicide levels appeared to be due to dilution as the water flowed downstream. Rates of reduction in herbicide levels showed that negligible concentrations would remain after water traveled a distance of 20 to 25 miles. The low concentrations of herbicides observed in the irrigation water likely would not be hazardous to crops or animals (Frank et al, 1970).

TCDD (the contaminant in Silvex) is nearly insoluble in water--0.2 ppb (Dow Chemical Company 1970). For this reason, it would be expected to remain on the surface of plants and soil at the application site. Because it is recalcitrant in soils, Kearney et al, (1973) concluded there would be "no ground water contamination problems." In the natural environment, any TCDD would be expected to be found associated with other constituents of the

formulation which are less soluble than water. They would form a thin film on water surfaces. Such films are expected to be degraded by sunlight, much like thin films on vegetation or the soil surface. Residues might, therefore, be substantially less than would be indicated from research with pure laboratory systems, that suggest that TCDD would be only slowly degraded in water (Kearney, 1973). TCDD could be transported in soil particles by erosion.

Direct application or drift of spray materials are the principal routes of entry to forest streams. This is a physical process, which can be markedly influenced by man. Herbicide concentrations in forest streams which are in or adjacent to treated areas range from nondectable limits (less than 0.001 ppm), to a maximum of about 1 ppm, with more than 99 percent of all values less than 0.01 ppm even when no particular effort is made to avoid direct application to stream surface with either ground or aerial application methods. Research has shown that the location of forest treatment units with a buffer strip along the streams reduced maximum herbicide concentrations in streams to less than 0.01 ppm with residues detected for less than 1 day after application (Abrahamson and Norris, 1976).

Cumulative Impacts

Cumulative impacts are not expected to occur as indicated in table 31. The relatively long persistence of tordon would have the longest half life of 8 - 12 months. With applications to the same areas of tordon two or three times during this ten year proposed action the cumulative increase would

increase about one and one half percent or less. This would be the worst case situation since the other proposed chemicals have short to moderate persistance and 2 or 3 applications over a ten year period would range from essentially zero to a trace accumulation.

Conclusions

1. Available information indicates that although some phenoxy herbicides may enter streams flowing through or adjacent to areas being sprayed, the levels in the streams will be very low. In 6 years of monitoring spray operations in western Oregon, scientists have never found phenoxy residues exceeding 0.1 ppm in western Oregon streams.

2. Long-term low-level pollution would be found if phenoxy herbicides are applied directly on marshy areas (USDA Forest Service, 1974).

3. Potential exists for contamination of water due to the erosion of soil particles containing herbicides or TCDD (the contaminate in Silvex).

4. Nearly all of the herbicide found in the stream results from the direct application of spray materials to the surface of the water.

5. The length of persistence (usually a few hours, but it can be a few days) is a function of the hydrologic nature of the area treated.

6. Ground water supplies would essentially not be impacted unless herbicides are sprayed on or near wetlands with a very high water table.

7. Some herbicide traces (a few ppb) may appear for a short period in nearly all streams which flow immediately adjacent or through treatment areas.

VISUAL RESOURCES

Impacts on visual resources are assessed according to guidlines in the Bureau's Manual Directive 6320, (Visual Resource Contrast Rating) which assesses degrees of change in basic elements on resource features. Allowable levels of change are established for each visual resource management classification. Mitigating measures can be used to maintain degrees of change. However, most of the classification and assessment work is incomplete at this time.

The impacts of the proposed use of herbicides as stated in Chapter I can be described only in general terms across all three sub-biomes.

Vegetation

Form

Unnatural forms may be seen and regarded as visual intrusions, for example, land ownership blocks, powerline rights of ways, and large areas of defoliated vegetation. As a result, vegetative variety will be reduced, lowering scenic quality. The proposed action involves mainly timber harvest areas ranging from 10-100 acres in size. Project area boundaries will conform to the boundaries of the harvest units thereby creating few new forms or visual intrusions of that nature. Vegetative variety will be reduced on treated areas.

Unnatural lines may be emphasized as a result of herbicide treatments and regarded as visual intrusions where such treatment areas conform to land ownerhip or timber harvest boundaries that are composed of straight lines not commonly found in the natural environment.

Color

Unnatural colors may be seen and regarded as visual intrusions, such as brown-black foliage, silver branches and trunks. Some spring flowering vegetation and fall color vegetation may be damaged. Vegetative color will be reduced, lowering scenic quality. The proposed action for 1978 identifies 14,824 acres of foliar sprays that would create brown vegetation lasting one growing season.

Texture

Unnatural textures may be seen and regarded as visual intrusions, such as defoliated vegetation, branches, and tree trunks. Vegetative variety will be reduced lowering scenic quality. Partially defoliated trees, brush and dead grass will result from the herbicide use. The proposed action indicates this would occur on approximately 74,436 acres annually. Unnatural texture created by treated vegetation may last only a year in the case of grasses to 5 or more for brush and trees depending on the recovery rate of the species affected.

Structures

Due to the lack of a specific visual resource inventory, there is no specific information relating the effects of proposed herbicide projects to structures near or on project areas.

Form

Unnatural manmade structural forms may be seen and regarded as visual intrusions (buildings, bridges, towers, etc.).

Color

Unnatural manmade structural colors may be seen and regarded as visual intrusions (buildings, bridges, towers, etc.).

Texture

Unnatural manmade structural colors may be seen and regarded as visual intrusions (buildings, bridges, towers, etc.).

Landform

Vegetatively hidden landform features such as interesting rock outcrop forms and fractured or eroded faces exist as potential scenic quality values that could be enhanced if concealing vegetation was removed.

Quality Values

Vegetatively hidden water features such as waterfalls and ponds may be exposed to view enhancing scenic quality values.

Vegetatively concealed interesting vistas may be opened up to view or interest patterns of young coniferous trees normally unseen with their striking evergreen color will contrast sharply with the dead silver colored vegetation, enhancing scenic quality values.

Structures

Interesting old or unique structures and unique architectural structures are designed for the specific site and landscape setting it is located in may be exposed to view enhancing scenic quality values.

Outstanding features once identified may deserve special visual resource management planning to maintain their scenic quality values for continual viewing.

Cumulative Impacts

Impacts of herbicide use on the visual resource in terms of unnatural lines and color are short term in nature because of the "bounce back" of new or resprouting vegetation in the treated areas within 1 or 2 years. Hardwood trees killed by treatment will persist as snags for a longer period depending primarily on their size.

Conclusions

1. Unnatural lines, texture, and color resulting from proposed projects will reduce scenic quality.

2. Unnatural forms such as bridges, buildings and roads may be more exposed to the public view after herbicide use and reduce overall scenic quality.

3. Scenic quality could be enhanced by exposure of unique natural features through creation of scenic vistas.

4. Classification and assessment work relating to scenic quality is incomplete at this time.

HUMAN

Impacts of herbicide use on humans as described in this chapter center principally on the human health hazards that may be associated with these chemicals. Relationships to timber harvest levels and associated job dependency are described in Chapters II and VIII.

The possibility of human health being impacted by the proposed use of herbicides on 74,436 acres annually by the Bureau is related to the proximity of project areas to human populations, the toxicity of the chemicals proposed for use, and the cumulative exposure of applicators.

Land Use

Proposed project areas are located in rural forest land areas with a relatively low human population density on adjacent lands. The chance for accidental human exposure is considerably less than a situation where herbicides are being applied adjacent to urban areas. Information that quantifies the degree of risk of exposure in relation to population density in absolute terms is not available.

Recreational pursuits take place on developed recreation sites. Occasional hunting, fishing, berry picking and hiking may occur on lands adjacent to or treated with herbicides.

Occasional herbicide use occurs in developed recreation sites to control poisonous plants such as poison oak. Although none is proposed for the 1978 program. Other plant pests around buildings may also require control. Herbicides are applied by hand held equipment during a period of time when the recreationist will not be exposed to the herbicide.

The possibility exists that hunters, fishermen, hikers and berry pickers will cross through areas treated with herbicides. These areas are not identified in the field with posters or other indicators along access roads to alert travelers that herbicide treatments have taken place.

Human Health

Impacts of proposed herbicide use on human health as described in this chapter is derived in large measure from the U. S. Forest Service Environmental Statement describing Herbicide Use for Region 6. This material has been supplemented by recent information that has become available in regard to the TCDD contaminant of Silvex and 2,4,5-T.

Toxicity

The chance of human beings exposed to herbicides used in forestry suffering adverse health effects impacted is related to the toxicity of the herbicides. Research has shown the chemicals proposed for use are relatively non-toxic. Therefore human exposure experienced as a result of herbicides applied at the rates described in Chapter I would expect to result in no injury to human beings. The minimal hazard that does exist diminishes with time after treatment. The final judgment on the risks involved with all pesticides rests with EPA in the registration and RPAR processes.

Selected information on the relative toxicity of herbicides and other chemicals in everyday use was compiled by Heilas (1967). This information is displayed below in table 39. LD_{50} as shown in this table is the rate at which test animals were fed in relation to body weight (mg/kg) and half or 50 percent of the test animals died.

Carrinogenic and Mutagenic Potential of Herbicides

Laboratory tests on various animals such as mice and rats can be conducted to evaluate the teratogenic, carcinogenic and mutagenic potential of 2,4-D, Silvex, Atrazine, Dalapon, and Tordon. The tests involve feeding these animals low levels over extended periods of time. The following results have been indicated from available publications.

Table 39 -- Relative Toxicity of Herbicides to Man (Heikes 1967)

Common Name or Designation	Some Common Trade Names	LD_{50} mg/kg	Toxicity Rating
2,4,5-T (2,4,5-TP)	Various (Silvex)	300	3
2,4-D	Various	500	4
Aspirin*		750	4
Dicamba	Banvel-D	1,040	4
Atrazine	Atrazine	3,080	4
Table Salt*		3,320	4
Picloram	Tordon	8,200	5

*Included for a comparison with chemicals in everyday use.

Toxicity Rating	Class	LD_{50} mg/kg	Probable Lethal Dose for 150 lb. man
1	Extremely toxic	Less than 5	A taste (less than 7 drops)
2	Very toxic	5-49	7 drops - 1 teaspoonful
3	Moderately toxic	50-499	1 teaspoonful - 1 ounce
4	Slightly toxic	500-4,999	1 ounce - 1 pint (1 lb.)
5	Nontoxic	5,000-14,999	1 pint - 1 quart
6	Nontoxic	15,000 & above	More than 1 quart

For the purposes of comparison, the data given in the above table for 2,4,5-T can be considered equivalent to the herbicide, Silvex (2,4,5-TP) proposed for use by the Bureau.

Herbicide	Teratogen	Carcinogen	Mutagen
2,4-D	**	No	No
Silvex	Yes	No	No
Atrazine	No	No	*
Dalapon	*	*	*
Tordon	No	Yes	*
Roundup	*	*	*

* Data not available

** Uncertain

The proposed action described in Chapter I differs significantly from the amounts and frequency of dosage prescribed in laboratory tests.

Silvex

Silvex (2,4,5TP) contains the contaminant, TCDD, that has been most commonly found in 2,4,5,T. Research has tended to concentrate on 2,4,5-T - TCDD effects. In order to fully explore the potential human health effects of TCDD, the following information is discussed regardless of whether it addresses TCDD in 2,4,5T or in silvex. Furthermore, most of the information is taken directly from the US Forest Service Environmental Statement on Vegetation Management with Herbicides (Region 6, 1978).

Rebuttable Presumption Against Registration (2,4,5-T)

The current "RPAR" proceedings on 2,4,5-T are directly related to Silvex because this chemical also contains TCDD (Dioxin). The environmental impacts of TCDD as currently known to EPA are described in detail in the Federal Register, Vol. 43, Friday, April 21, 1978. A copy is on file for review at the Bureau's Portland, Oregon Office.

The Code of Federal Regulations requires that, "a rebuttable presumption shall arise if a pesticide's ingredients ... (i) induces oncogenic (tumor causing) effects in experimental mammalian species or man as a result of oral, inhalation or dermal exposure."

Studies indicate that 2,4,5-T containing less than .05 ppm TCDD and/or TCDD alone have caused oncogenic effects in two mouse strains and one rat strain (Federal Register, Vol. 43, No. 78, April 21, 1978, page 17124).

The Code of Federal Regulations provides that "a rebuttable presumption shall arise if a pesticide's ingredients ... (p) produces any chronic or delayed toxic effect in test animals at any dosage up to a level as determined by the administrator which is substantially higher than that to which humans can reasonably be anticipated to be exposed taking in margins of safety."

Studies have shown that 2,4,5-T containing 0.5 ppur or less TCDD produces teratogenic (deformaties) and/or fetotoxic effects in mice at 30 mg/kg,

in rats at 100 mg/kg, in hamsters at 40 mg/kg and in birds at 1 mg/kg (op. cit. page 17128).

The EPA working group on pesticides has concluded that an ample margin of safety does not exist for the population at risk (women of child-bearing age) for dermal and inhalation exposure and for cumulative oral, dermal and inhalation exposure to both 2,4,5-T and TCDD (op. cit. page 17128).

The same group concluded that sufficient evidence does not exist to initiate a rebuttal presumption based on the pesticide's ingredient(s), metabolite(s) or degradation products tendency to induce mutagenic effects as determined by multitest evidence.

Bioaccumulation

Bioaccumulation means the uptake and at least temporary storage of a chemical by an organism. TCDD is present in such minute quantities in the environment that toxicity from primary exposure (that is, exposure resulting from indirect ingestion of vegetation or water, dermal absorption or inhalation is unlikely) (Norris 1977). Concern about bioaccumulation is that it may be a mechanism by which organisms collect or concentrate TCDD from primary exposure. These organisms would then carry possibly toxicologically significant residues as food sources for other creatures. For instance, the amount of TCDD required to produce harmful effects in humans is spread out over such an area that direct personal exposure to that amount is

unlikely. But if deer bioaccumulate TCDD as they feed, human consumption of these deer could conceivably lead to significant human exposure. The question is, then, does bioaccumulation occur, and if it does, to what degree?

Physical-chemical properties are good indicators of the potential for bioaccumulation. Chemicals with low water solubility and high fat solubility have a strong potential for bioaccumulation. DDT is an example of a chemical which is low in water solubility (0.001 ppm) and is high in fat solubility (86,000 ppm in corn oil). DDT is known to bioaccumulate in exposed organisms. TCDD is low in water solubility (0.002 ppm) but not particularly fat soluable (47 ppm in corn oil). The ratio of oil solubility to water solubility is 86 x 106 for DDT and 0.2 x 10^6 for TCDD. These physical-chemical properties suggest that TCDD would bioaccumulate in exposed organisms but probably to a lesser degree than DDT. The degree of bioaccumulation depends on the magnitude and duration of organisms exposure.

Bioaccumulation can also be studied in laboratory animals or in small laboratory ecosystems. Several such studies have been done. Data from laboratory feeding studies of mammals and fish, and from laboratory-scale, aquatic ecosystems are described below.

In laboratory feeding studies with repeated exposure, Fries and Marrow (1975) report that after 6 weeks of exposure, rats reached a steady state which was 10.5 times the daily intake. Rose et al., (1976) also report steady state concentration in rats in 7 weeks at little more than ten times

the daily intake level. These data establish that in laboratory feeding studies, animals which ingest TCDD in their diet will accumulate TCDD in certain body tissues, at least for as long as exposure continues. It is also clear, however, that TCDD is not irreversibly accumulated in these feeding studies. Piper et al., (1973), Allen et al., (1975), Rose et al., (1976), and Fries and Marrow (1975) all found a halftime for TCDD residence in the body which ranged from approximately 12 to 30 days. These data indicate that once exposure to TCDD stops, the body burden will decrease. In a feeding study with rainbow trout, Hawkes and Norris (1977) report limited and preliminary data indicating that on a whole body basis, TCDD levels in fish are approximately of the same order of magnitude as the level of TCDD in the food they consume.

Several laboratory-scale aquatic ecosystem studies have been conducted with TCDD. Matsumura and Benezet (1973) exposed several organisms in model aquatic ecosystems to TCDD. Unfortunately, in most of their studies, the concentration of TCDD in the water was substantially in excess of the limits of its solubility, preventing meaningful interpretation of the data. In one experiment, however, TCDD was adsorbed on sand in the bottom of the aquaria and Matsamura and Benezet found 0.1 ppb TCDD in water and 157 ppb in brine shrimp, to give a concentration factor of 1,570.

Isensee and Jones (1975) also used a laboratory-scale, aquatic ecosystem to study TCDD bioaccumulation in mosquito fish, fingerling, channel catfish, algae, duckweed, snails, and water fleas. TCDD was adsorbed on soil which,

when equilibrated with the water, resulted in TCDD concentrations in water ranging from 1,330 to 0.05 ppt. Concentrations in excess of 200 ppt exceed the limits of water solubility for TCDD and prevent meaningful interpretation of those bioaccumulation data. In experiments where the water concentration was less than 200 ppt, bioaccumulation ratios (that is, the ratio of the concentration of TCDD in the organism to the concentration of TCDD in the water) ranged from 2×10^3 to 63×10^3. They found a strong, positive correlation between the concentration of TCDD in tissue and concentration of TCDD in water for all organisms. Isensee (1977) recalculated this data from a dry weight basis to a fresh weight basis in order to make the data more comparable to other studies. He reports the average degree of bioaccumulation ranged from 2 to 7×10^3 times the water concentration of TCDD. The total amount of TCDD accumulated was directly related to the water concentration. Equilibrium concentrations in tissues were reached in 7 to 15 days. He reports TCDD bioaccumulates to about the same magnitude as many of the chlorinated hydrocarbon insecticides in model aquatic ecosystems.

These results from laboratory studies indicate that organisms exposed to TCDD in their diet or in aquatic ecosystems will bioaccumulate TCDD.

The degree of bioaccumulation which occurs from the use of TCDD-contaminated herbicides in forest ecosystems depends on the magnitude and duration of organism exposure. In laboratory studies, organism exposure is assured through regular addition of TCDD to the food for feeding studies or, in aquatic ecosystems, through the placement of a substantial reservoir of TCDD

adsorbed on sand or soil resulting in continuous release of small quantities of TCDD to water. In the natural environment, (in contrast to laboratory studies) several processes operate to reduce or eliminate TCDD exposure to organisms and thereby minimize the opportunities for bioaccumulation. Crosby and Wong (1977), as mentioned earlier, report TCDD in herbicide formulations disappears rapidly from vegetation and soil when exposed to sunlight. This mechanism would markedly reduce or eliminate organism exposure through dermal contact with or ingestion of contaminated vegetation. In the aquatic environment, the likelihood of 2,4,5-T and TCDD entry to aquatic systems is slight, but if it does occur, chemicals in the water are rapidly diluted and carried downstream with streamflow. TCDD which adsorbs on sediments provides a reservoir of TCDD in the aquatic environment similar to that provided in the model aquatic ecosystem studies. However, in the real stream system, TCDD liberated from the sediments is quickly moved downstream with streamflow, minimizing the opportunity for bioaccumulation by a particular organism.

The third approach to evaluating TCDD bioaccumulation is to look directly for evidence of bioaccumulation in the field. Several efforts in this regard have been made, but with markedly different sophistication and sensitivity of analytical methods. For instance, Woolson et al., (1973) analyzed samples of eagle tissues from various regions in the United States. No TCDD was detected. The minimum detection limit, however, was 50 ppb, which is not an adequate level of sensitivity to properly evaluate bioaccumulation of TCDD, considering the inherent toxicity of the molecule.

Young et al., (1976) studied the behavior and bioaccumulation of TCDD in animals from the Elgin Air Force site used for equipment development and testing for application of herbicides in Vietnam. The study area received massive applications (1,000 pounds per acre) of 2,4,5-T, much of which contained TCDD in excess of 1 ppm. Analysis of soil from the test site shows TCDD residue levels in the range of 10 to 1,500 ppt. Analysis of rodents, reptiles, birds, fish, and insects shows the presence of TCDD in tissues of at least some of the organisms involved in this test program. The results of this test substantiate the theoretical data and the data from laboratory tests which indicate that, if TCDD is available to organisms in the field, it will be bioaccumulated. The degree to which herbicide used at Elgin test site was contaminated with TCDD and the massive rates of application, however, make this data not directly applicable to the use of the herbicides in forestry. It is useful to indicate TCDD does have a potential for bioaccumulation.

Other studies done in connection with registered uses of 2,4,5-T for vegetation control have found relatively little TCDD in biological samples.

In 1973-74, the Environmental Protection Agency, cooperatively with the Forest Service, conducted a monitoring program for TCDD in tissues of animals from several areas in western Oregon and Washington which had been recently treated with 2,4,5-T. The methodology employed at that time was not adequate to establish the presence of TCDD in these environmental samples, but was adequate to determine which samples did not contain TCDD in the low-to-middle part per trillion range. Results of the monitoring program

showed approximately 85 per cent of the samples did not contain detectable levels of TCDD. The remaining samples which are described by EPA as "minutely suggestive" for TCDD have been subjected to confirmatory analysis. Results are contained in Appendix G of the U.S.F.S. Region 6 Final Environmental Statement, ref: Vegetation Management with Herbicides, 1978.

The EPA beef fat monitoring program, which was initiated in 1974, has been completed. Samples of beef fat (85) and liver (43) from animals grazing in areas treated with 2,4,5-T have been analyzed for TCDD. Approximately 25 per cent of these samples are from animals not exposed to areas sprayed with 2,4,5-T. EPA reports (EPA Draft Dioxin Position Document, Appendix D) on sample shows a positive TCDD level at 60 ppt, 2 samples appear to have TCDD at 20 ppt, and 5 may have TCDD in the range of 5 to 10 ppt. EPA states, "The analytical method is not valid below 10 ppt." Of the 43 liver samples analyzed, 1 sample was below detection limits for quantitation. A fat sample from the same animal showed no TCDD residue. The results of the EPA beef fat monitoring study indicate bioaccumulation of TCDD in grazing animals is not sufficient to result in regularly detectable levels of TCDD greater than 10 ppt in beef fat and liver.

Newton (1975) reported on the analysis of livers from mountain beavers captured 2 months after a forested area in western Oregon was treated with 2,4-D and 2,4,5-T. Analysis of the tissues showed no detectable levels of TCDD with a minimum detection limit of less than 10 ppt. Mountain beavers normally consume large quantities of vegetation, thereby affording them

substantial exposure to herbicide-treated plants. In addition, they are a burrowing animal which will put them in intimate contact with herbicide and TCDD present on the soil surface.

Shadoff et al (1977) conducted a broad study to determine whether TCDD was accumulating in animals due to the use of 2,4,5-T in the midwestern United States. They did not detect any TCDD (detection limit which averaged less than 10 ppt) in samples of fish, water, mud, and human milk from areas in Arkansas and Texas.

Meselson (1977), in a tentative and preliminary report to Congressman Weaver, indicated some samples of human milk from areas in which 2,4,5-T is used contained detectable levels of TCDD. Meselson reported 3 samples out of 6 from Texas, and 1 sample out of 5 from Oregon contained detectable levels of TCDD, but the levels of detection were substantially below the 10 ppt level established by EPA in the beef fat monitoring program as the minimum acceptable, reportable level.

The results of these various tests indicate that, if TCDD is present in the environment in a form which is available to organisms, then bioaccumulation would occur if organisms are exposed. This concept is supported, both from an examination of the physical-chemical properties of TCDD, as well as by studies of its behavior in animals exposed through feeding studies or in laboratory model aquatic ecosystems. The degree to which bioaccumulation of TCDD occurs in the field is dependent not only on the physical-chemical properties of the

compound, but also on the persistence and availability of TCDD in the environment. Mechanisms of degradation and dilution which operate in the natural environment reduce the opportunities for organisms to be exposed, and thereby reduce the degree to which bioaccumulation might occur.

Monitoring for TCDD residues in animal samples from areas where 2,4,5-T is used at normal rates of application tends to show little or no detectable bioaccumulation of TCDD. In the beef fat monitoring study, for instance, only 3 samples out of 63 contained TCDD at levels within the range at which the analytical method is valid quantitatively. The EPA monitoring for TCDD, in animal samples from western forests conducted prior to June 1974, shows at least 85 per cent of the samples do not contain detectable levels of TCDD (the other 15 per cent require confirmatory analysis). The study of TCDD residue in livers of mountain beavers from areas treated with 2,4,5-T shows no detectable levels of TCDD, with minimum detection limit of less than 10 ppt. A widescale monitoring of water, sediment, fish, beef, and human milk from areas in the midwestern United States where 2,4,5-T has been used operationally also shows no detectable TCDD residues at minimum detection levels which average 10 ppt. These monitoring efforts indicate that substantial bioaccumulation (sufficient to produce residue levels in excess of 10 ppt TCDD in the majority of the population) is not occurring in animals in or near areas treated with 2,4,5-T in current operational programs.

Cumulative Effects of TCDD--Some toxicologists interpret recent experiments with primates (Allen et al., 1977) as indicating that the effects

of sublethal doses of TCDD may be cumulative and death results if a sufficient number of sublethal doses are received. Stated another way, these experiments may suggest that the lethal amount of TCDD in primates is approximately the same regardless of whether the dose is received all at once or in numerous small doses. If this is true, it means any estimate of an acceptable exposure level must assume additive effects over long periods.

A primate study by Allen (1977) used TCDD in the diet at 500 ppt. This is a level substantially greater than likely to be available to organisms in the forest, even immediately after application of 2,4,5-T. Norris (1977) estimates fnitial TCDD residue levels on vegetation of 5 to 10 ppt immediately after application. Crosby and Wong (1977) report TCDD halflife on vegetation of only a few hours when exposed to sunlight. Therefore, the probability of chronic exposure to levels of 500 ppt TCDD is remote. If the response of primates in Allen's study is proportional to the dose received, exposure to 5 ppt would permit survival for 100 times as long as reported by Allen. This would be well beyond the normal life span of primates.

Additional experimentation with primates is necessary to clarify the Allen finding. Chronic exposure at levels relevant to possible environmental residue levels is needed. Periodic exposure to higher levels (to 500 ppt), with periods of no exposure between, also need to be tested. The exposure level used by Allen may have overloaded or inactivated the detoxication and repair processes of organisms usually employed in responding to chronic toxic exposure. The exposure regimes described would test this hypothesis.

Cumulative effects of TCDD have not been seen in other species. In guinea pigs, dose rates of 0.2 ug/kg weekly for 8 weeks provided a total dose almost three times the LD_{50}, but no deaths occurred, and organ changes, while measurable, were not severe. Voss et al, (1974) also reported that rats accepted about three times the LD_{50} of 20 ug/kg over a 13-week period without lethality.

Experiments conducted thus far are not adequate to determine with any certainty that TCDD does or does not have cumulative effects in animals. The evidence to indicate possible cumulative effects comes from a single study with primates. The possibility of cumulative effect is important, and carefully designed experimentation is needed to clarify the point. However, there is insufficient evidence at this time for the Forest Service to determine that use of 2,4,5-T, as registered by EPA, would result in cumulative toxic effects from TCDD in people, or animals likely to come in contact with spray materials.

Although TCDD is distributed in the forest environment as a contaminant in 2,4,5-T and silvex, the amount of TCDD (0.1 ppm in 2,4,5-T is so small and spread over such a great area that exposure to a toxic dose is highly unlikely. Tschirley (1971) and the New Zealand Department of Health (1977) offer "worst-case estimations" supporting the remoteness of this possibility. Additionally, TCDD as it occurs in actual herbicide formulations degrades rapidly (within a single day), further decreasing the possibility of contacting a toxic dose.

Socio

Concern will be expressed by individual citizens about potential adverse impacts on agriculture crops, garden crops, animals, domestic water supplies, and direct contact from drift occurring during spraying or pilot error.

Other individuals or organized groups regardless of location will protest the entire use of chemicals because their value system is based on the natural environment undisturbed by man-made chemicals.

Downstream water users, such as fish hatcheries, domestic water systems and irrigation draw off can also be expected to express concern about anticipated impacts of upstream herbicide use.

Application Methods

The chances of an applicator being exposed to contact with the herbicides being applied is remote if such chemicals are mixed and applied according to label instructions and with well maintained application equipment. However, in the event that leaks or splashings occur, it is probable that the highest degree of exposure is related to the following type of application in descending order; hand, backpack, truck and aerial. Proposed annual use of herbicides by these methods is indicated by the 1978 program is; hand - 4,179 acres, backpack - 5,714 acres, truck - 1,825 acres and aerial - 62,699 acres.

Cumulative Impacts

Repeated exposures to herbicides may occur to applicators if their livelihood is herbicide application. Cumulative effects that impact human health are not expected. Bioaccumulation of TCDD (dioxin) in the food chain is a matter of a disagreement between scientists.

Conclusions

1. Direct human exposure to the herbicides proposed for use will be rare. The relatively non-toxic nature of these herbicides indicates no injury is anticipated to individuals that are exposed.

2. Potential for adverse human effects from the TCDD (dioxin) found in silvex is currently undergoing a formal review process by EPA. Some studies indicate that tumors and deformities result in test animals. An EPA committee has made the judgment that an adequate margin of safety does not exist for women of child bearing age exposed to cumulative effects of dermal, oral and inhalation exposure of 2,4,5-T and TCDD.

3. A portion of the citizens living adjacent to or near proposed project areas will protest the use of chemical herbicides.

4. Hunters, berry pickers, hikers and other outdoor enthusiasts may cross through or recreate in areas recently treated with herbicides.

CHAPTER IV

MITIGATING MEASURES THAT WILL BE INCLUDED IN THE PROPOSED ACTION IN ADDITION TO THOSE DESCRIBED IN CHAPTER I

The action proposed is a Bureau motion on Bureau administered public land. Federal, State, and local requirements are included in the proposed action, project design features, Chapter I.

Mitigating measures that will be used in addition to those required by Chapter I (as project design features) have been identified as a result of the analysis process. These additional measures are described in this chapter and will be requirements in any herbicide use that is authorized. Each district may identify additional mitigating measures applicable to specific local conditions during the development of land use and timber management activity plans and environmental assessment records (EARs) prepared for herbicide project proposals.

Impact	Mitigating Measures
VEGETATION	
Vegetation in the form of agricultural crops pasture land and grass on privately owned land adjacent to aerially sprayed areas may be impacted from drift.	Require an unsprayed buffer strip of at least 100 feet horizontal distance along all adjacent land being used for pasture or cropland,

Impact	Mitigating Measures
TERRESTRIAL WILDLIFE	
1. Herbicide applications in crucial wildlife winter ranges could have adverse impacts if limited forage or cover is affected.	1. Identify crucial wildlife winter ranges and calving areas through the Unit Resource Analysis phase of the Bureau Planning System and schedule herbicide treatments so they will not exceed 15 percent cumulative total of the 60 percent forage requirement ot deer and elk (60 percent forage-40 percent cover, Thomas, et al., 1976). Alternate areas or year of herbicide treatment to minimize impacts on important wildlife cover and forage.
2. Tree snags that may endanger helicopter operations are usually cut prior to aerial spraying of herbicides. Pilot safety is increased with the removal of these tall snags. These snags are valuable to cavity dwelling birds and other wildlife forms.	2. Retain a minimum of one snag per 3 acres on those areas to be aerially treated with herbicides.

Impact	Mitigating Measures
Disturbance by man and machines is likely to cause some adverse impacts during critical mating or calving seasons.	Critical areas will be identified and either avoided or deferred as necessary.

SOIL

1. There is a potential for herbicides to reach water courses through surface run-off and by leaching when sprayed on compacted surfaces and stony, shallow, rapidly drained soils.	2. Avoid the application of herbicides to roads and stony, shallow, rapidly drained soils.

AQUATIC ORGANISMS - WATER QUALITY

1. There is expected to be some contamination of streams during aerial and truck-mounted application of herbicides. The action mandates bufferstrip width for each method of application along Class I streams but does not specify a	1. There will be a bufferstrip along all streams flowing at the time of appplication to protect water quality and the aquatic environment. The minimum horizontal distance on both sides of the stream shall be:

Impact	Mitigating Measures
width for other streams flowing water. The lack of specified width on other streams could result in greater contamination than should occur with a minimum specified width of buffer.	a) 100 feet wide when herbicide is aerially applied. b) 25 feet wide when herbicide is applied by truck-mounted equipment. c) 10 feet wide when herbicide is applied by hand.
2. The establishment of fixed width bufferstrips along flowing water when applying herbicides does not fully consider the true streamside riparian vegetation zone which may be wider or narrower. The treatment of riparian vegetation that does not fall within the bufferstrip with herbicides will cause damage to some vegetation important to both aquatic and terrestrial organisms.	2. All crucial or critical riparian habitat designated by each district in the Unit Resource Analysis phase (URA) of the Bureau planning system which contains a vegetation component which may be significantly impacted by a proposed herbicide application will be protected. These habitats are to be cataloged by qualified district biologists and their preservation will prevent the loss of habitat that would not have otherwise been considered in a fixed bufferstrip width designation.
The highest chance of contamination of waters in streams, bodies of water and	Dicamba and Tordon will only be applied along roadsides when ditch-

Impact	Mitigating Measures
marshes is by water soluable Dicamba and Tordon. Both of these are used in roadside treatments of vegetation. Application during rainy weather could result in ditchwater carrying the spray in amounts exceeding the recommended maximum for short periods into streams and water bodies.	lines are not flowing water and rainfall is not expected within 24 hours.
It is anticipated that there will be water contamination and riparian zone damage caused by pilot error in identifying bufferstrips and riparian zones that are to be protected.	Areas to be protected from herbicides will be clearly marked with paint, flags, or other highly visible means when no other obvious boundary markers such as a road or tree line exists to delineate the spray unit from the bufferstrip or adjacent area requiring protection.

VISUAL RESOURCES

Brown vegetation resulting from herbicide treatment is visible	Where possible apply effective dormant sprays during the winter-

Impact	Mitigating Measures
along forest roads and in plantations.	time when the leaves are gone. Especially for road maintenance, includes a combination of mechanical cutting and herbicides.

HUMAN HEALTH

Residents on land adjacent to project areas may not understand the purpose, type of herbicide to be used, and the minimum health hazards associated with the project.	Require consultation with adjacent landowners and downstream water users to explain the proposed project in full prior to application.
Recreationists may not be aware that they are entering an area that was treated with herbicides.	Install temporary project area boundary signs that identify the herbicide used, date applied, and purpose.
The safety margin in relation to human health established for herbicides containing TCDD (dioxin) has been judged by EPA to be too small for women of	Women of child-bearing age will not be allowed to mix, load, apply or monitor the environmental impacts of Silvex.

Impact	Mitigating Measures
child-bearing age exposed to cumulative oral, dermal, and inhalation. The basis for this judgment is subject to public review through the "RPAR" process.	

Chapter V

ANY ADVERSE ENVIRONMENTAL EFFECTS WHICH CANNOT BE AVOIDED, SHOULD THE PROPOSAL BE IMPLEMENTED

This chapter describes residual impacts of the proposed action that may exist after all the mitigating measures have been implemented.

VEGETATION

Some species of nontarget plants will be damaged by herbicide applications. Broadcast applications encompass the entire plant community in the target area. Even spot applications occasionally damage adjacent nontarget plants.

The use of herbicides for foliar sprays in vegetative management can result in plant desiccation that may increase forest fire hazard during the summer months.

There is a slight risk that a concentration of a plant species on the tentative endangered or threatened plant species list will occur in a project area and go undetected during the planning and layout phases. Such plants may be killed depending on their susceptibility to the herbicides being used on that project. Other plants that cannot tolerate shade will die out as a result of competition as the vegetation moves forward in successional stages to dominance by conifers.

Non-target domestic plants on adjacent land will suffer some damage infrequently as a result of pilot or applicator error.

TERRESTRIAL WILDLIFE

No direct toxicological effect will occur to wildlife from the use of herbicides. The contaminant TCDD in Silvex may be picked by wildlife in minute quantities. The significance of TCDD in animals in terms of potential impacts is under study by EPA.

An indirect adverse effect of repeated herbicide applications will be a change in plant communities resulting in a loss of habitat for some species and a reduction in the numbers and diversity of wildlife species found on the areas before treatment.

Nectar feeding insects, such as honey bees, may suffer minor toxic effects if they drink water containing accumulated herbicide residues that have been trapped in flowers.

Cavity dwelling wildlife may be reduced in numbers and diversity as a result of the loss of snags normally used for habitat.

Reptiles, amphibians, and occasionally a bird may be coated with herbicide carrier (diesel oil). Little is known about diesel oil impacts on these species.

SOIL

No adverse impacts to soils from the use of herbicides, when applied at recommended rates, has been documented. In addition there is no evidence which indicates that herbicides will significantly inhibit the growth and number of soil biota. Theoretically,reductions in plant cover would decrease litterfall temporarily, thereby leading to a temporary decrease in certain decomposer and consumer organisms.

Observations indicate that surface erosion does not result with temporary reduction in live ground cover because the protective litter layer and "dead" cover resulting from the herbicide application remains to provide effective erosion control until vegetative regrowth occurs.

Leaching into subsurface water may occur when herbicides are accidentally applied to shallow, rapidly drained soils.

AQUATIC RESOURCES

The presence of herbicides in water supporting aquatic life will undoubtedly exist for a short time after some herbicide applications even when mitigating measures and project design features are carried out to the fullest possible extent. This fact has been documented by nearly all spray monitoring efforts and many research projects (Norris, 1977). These levels expected under normal

conditions of application will not reach either the lethal limits required to kill aquatic life LD^{50} or the recommended stream concentration maxima (EPA, 1977).

Researchers have noted that more work on sub-acute levels of toxicity is needed to clarify the impact on aquatic organisms (Thut and Haydu, 1971), (Norris and Moore, 1971). Present research established acute LD^{50} limits and effects beyond this are not scientifically substantiated. Therefore, present research indicates no measurable, visible or documentable adverse impacts on aquatic organisms would result from the proposed action.

The possibility of a major spill into a fish hatchery feeder stream or spawning stream is possible but extremely unlikely when the restrictions imposed on applications are analyzed. However, should such an event occur, losses in fish populations in the immediate vicinity of the spill would occur. The magnitude of these losses are not quantifiable, however, they could include part or all of the population in the immediate impact area. The duration of the impact would be short-term in nature.

The application of silvex is proposed on 42,000 acres. Some evidence indicates that the contaminant of Silvex (TCDD), may bioaccumulate in fish. However, the possibility of such accumulation under the conditions proposed for use would be extremely small. The time period that TCDD would remain in fish is unknown. Data on long term impacts are not available.

The possibility for damage to riparian vegetation will always be present. The development of riparian zone management policy will reduce impacts. It is anticipated that occasional overspray of riparian vegetation will accidentally occur. These incidents should be localized (less than a few 100 feet) and not significant enough to alter stream temperature or nutrient cycling to a degree that any impact on aquatic life would be measurable.

WATER

Herbicides may get into water supplies by direct application to previously undetected areas of free water, drift from adjacent areas, leaching in shallow soils, and movement of herbicides to streams by mass overland flow resulting from periods of intense precipitation occurring shortly after application. These sources could introduce low levels of herbicides for short periods of time leading to a brief exposure of aquatic organizms or other water users in the immediate area. However, no measurable adverse impacts to organisms from these low levels have been identified.

VISUAL RESOURCES

Visual impacts, such as brown, chemically killed vegetation along treated roadsides will be of short duration. Other esthetic and intangible values associated with a preference for a natural ecosystem, which is highly valued by some individuals, will be disturbed.

The lack of a completed visual resource inventory and management plans based thereon will result in a loss of some visual resource values.

HUMAN HEALTH

No direct unavoidable effects to man are anticipated from the use of herbicides. There will be normal related hazards to workers handling chemicals; however, these hazards will be minimized through training and adherence to established safety practices and standards.

The possibility of the contaminant of Silvex (TCDD) accumulating in the food chain and indirectly affecting or potentially affecting man's health is currently under investigation by EPA.

CHAPTER VI

RELATIONSHIP BETWEEN LOCAL SHORT-TERM USES OF MAN'S ENVIRONMENT AND THE MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY

The use of herbicides can be viewed as short-term use. The timber growing and harvesting cycle may take 70-100 years, whereas the use of herbicides may take place within a 6-week period two or three times early in the life of a forest plantation.

The long-term effects of herbicides are related to the shift in succession of forest land vegetation. Similar changes occur under natural conditions. Coniferous stands of trees that are destroyed by fire or wind are replaced by seral vegetation of grasses, forbs, and brush and gradually by conifers that shade out some of the earlier vegetation. Use of herbicides speeds up the process and enhances the basic capability for timber production. Application of herbicides has a short-term effect by disrupting some plants or retarding growth of some plants so that conifers may survive and grow better that under natural conditions.

VEGETATION

Mature timber is harvested to meet the needs of today, and new timber crops are grown to meet the needs of future generations. The decision to harvest and grow new timber crops to promote community stability (O&C Act,

1937) dictates the need for prompt and effective reforestation. Long-term timber production in enhanced by the use of herbicides or other effective means of vegetation management. Timber yields are increased in the long term by 30 to 50 percent.

Short-term trade offs are reductions in non-coniferous vegetation early in the life of a forest.

TERRESTRIAL WILDLIFE

Herbicide treatment of brush usually results in a short-term gain for big game by increasing availability of succulent regrowth. After 10-20 years, trees dominate and brush species are reduced. Long-term gains for deer and elk can result from proper planned use of herbicides in the continuous process of converting brushfields to conifer stands, thereby developing a continual supply of areas in the early stages of succession which are the most productive for wildlife food. Conversely escape or resting cover for big game may be destroyed in the short term by herbicide use.

However, retreatments and the general impact of herbicides on the early seral stage is a shortening of the period which they are productive for wildlife. The impact on many birds for a given treatment area may be adverse and long term. Both numbers and diversity will be reduced. Each acre within a forest managed on an 80-year rotation must go through all

successional stages to climax and harvesting until suitable habitat is once again available to those wildlife species that are dependent on the early seral stages. Quantification of the reduction is not possible without further comprehensive research.

SOIL

No loss in the basic productivity of the soil is expected from the use of herbicides.

AQUATIC RESOURCES

Long-term use of the land by man for timber production and the impact of herbicide in this use is not expected to benefit or endanger aquatic life. A short-term loss of aquatic organisms could be expected should a lethal concentration of chemical enter the aquatic ecosystyem following an accident. The overspray of riparian vegetation due to pilot error or other causes can result in the short-term loss of nutrients provided the stream by the damaged vegetation and a raising of stream temperature through canopy defoliation. It is expected that these unquantified adverse effects would fully disappear in 10 to 20 years.

The long-term effect on aquatic life based on analysis of limited research data is unknown. Research is underway to analyze the impact on organisms by chemicals and this will continue for many years before a fully credible

scientific statement of the effects on long-term productivity can ever be made. However, there is presently no evidence of long-term adverse impact on the productivity of the aquatic environment or aquatic organisms.

WATER

Detectable herbicide residues in water disappear within a few hours to a few days. No long-term impacts are known. Water yield from treated areas may increase slightly for a short period as a result of the reduction in vegetative cover. Long-term water quality and quantity will be unaffected by the proposed action.

VISUAL RESOURCES

The proposed action will reduce the diversity of color and variety of vegetation on treatment units. The tendency to develop uniform coniferous stands of trees will reduce scenic quality in the long term.

HUMAN HEALTH

Control of encroaching vegetation will keep rights-of-way usable. Needed sight distances will be maintained to provide safe driving conditions.

No long-term human health effects are known to result from the proposed action.

CUMULATIVE IMPACTS

Simultaneous use of herbicides by the U.S. Forest Service, State Forestry Department and privately owned forest lands will not result in significant cumulative short-term adverse impacts because of: 1) the rapid degradation of herbicides in the soil and water, 2) non-contiguous treatment areas, and 3) variation in application timing. Furthermore, less than 2 percent of the land base will be subject to treatment at any one time. The cumulative impact on timber production will be significant in the long term in the form of a higher level of timber harvest (30-50 percent) that will be responsive to predicted shortages of wood supply within the next 20 years.

CHAPTER VII

IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES WHICH WOULD BE INVOLVED IN THE PROPOSED ACTION SHOULD IT BE IMPLEMENTED

The proposal will require the use of about 200,000 gallons of non-renewable fossil fuels for herbicide carrier, helicopter fuel and vehicle operation. Additional fossil fuels will be used to manufacture the 301,000 pounds of herbicide proposed for application. These energy losses are considered irreversible and irretrievable.

No other irreversible or irretrievable commitment of resources will result from the proposed action.

CHAPTER VIII

ALTERNATIVES TO THE PROPOSED ACTION

This chapter identifies and analyzes alternatives to the proposed action as described in Chapter I. Alternatives considered are:

A. Vegetation management with all available herbicides except Silvex.

B. Vegetation management without chemical herbicides.

C. No vegetation management.

Environmental impacts of the various alternatives have been identified in the analyses. Quantification of all impacts in absolute terms is not possible with the data base available.

VEGETATION MANAGEMENT WITH ALL AVAILABLE HERBICIDES EXCEPT SILVEX

(Alternative A)

The proposed action describes the intended use of Silvex on 42,000 acres or 60 per cent of the 74,436 acres proposed for treatment in 1978. Projections for 1979 indicate a reduction in program magnitude for Silvex to 21,565 acres or 30 per cent of the total proposed annual program. This reduction is a result of increased use of herbicides recently registered for forestry use in Oregon.

The purpose of this alternative is to explore the feasibility of chemical herbicide alternatives to Silvex. This includes the use of newly registered herbicides as well as increased use of 2,4-D.

Analysis Method

The analysis is described in the following steps: 1.) It identifies the vegetation normally treated with Silvex, 2.) It identifies alternative chemical herbicides that could be used to treat this vegetation, 3.) It portrays in tabular form the alternative herbicides that could be used for each project proposing the use of Silvex in 1978. Subsequently, the analysis examines the environmental impacts of the use of Silvex substitutes that may be in addition to those impacts described in Chapter III. Project design features described in Chapter I and additional environmental

protection measures described in Chapter IV are considered an integral part of alternative A.

Conclusions drawn from the analysis are presented at the end of the discussion of this alternative.

Chemical Alternatives to Silvex

Used alone or in combination with 2,4-D, Silvex gives satisfactory control of the following species: snowbrush ceanothus, varnishleaf ceanothus, golden chinkapin, vine maple, salmonberry, thimbleberry, and poison oak. Silvex is also sometimes used for basal treatment of bigleaf maple clumps and for topkilling California hazel. Other herbicide treatments may be used to treat some of these plants with some loss of effectiveness and an increase in cost.

Two chemicals, Krenite and Roundup, were recently registered for forestry use in Oregon. These herbicides are included in the proposed action but may be further substituted for Silvex. Neither of them contain the contaminant, TCDD. Both require water carriers. The value of these two chemicals on the various sites managed by BLM has not yet been completely determined. Their safety and effectiveness is not documented by the results of the extensive field testing available for the phenoxy herbicides. It may be possible to identify additional chemical replacements for Silvex over time as further testing is done.

It is also possible to use increased applications or rates of 2,4-D Tordon may also sometimes be substituted. Another new chemical, Triclopyr, appears to be useful for site preparations, but is not now registered for forestry use. The usefulness of these herbicides as presently known is described in the following paragraphs.

Krenite

Projects totaling 2,481 acres are included in the proposed action for 1978 in the Salem, Eugene, and Coos Bay districts. Increased use is projected for 1979.

Krenite is the trade name for AECP (Ammonium ethyl carbonoyl phosponate). This substance is a growth regulator that appears to inhibit formation of new growth on deciduous species. Krenite appears to be very effective on deciduous brush, but ineffective on most evergreens. Krenite is registered for both release and site preparation projects in Oregon. Krenite may suppress terminal growth of moderately resistant species, including conifers. Hemlocks may be severely damaged (Newton, 1977). Extensive field testing is advisable before Krenite is used for conifer release on a broad basis (Gratkowski, Stewart and Weatherly, 1978).

Krenite may be used to control salmonberry, vine maple, and cascara. Four pounds per acre will control alder/salmonberry mixes, but will severely damage conifers. The chemical appears to be most useful in the Northwest

Coastal Coniferous sub-biome. This sub-biome exists in the Coast Range in parts of Salem, Eugene and Coos Bay districts. Krenite costs about 6 times as much as Silvex to achieve essentially the same control of target species.

Roundup

Roundup is the trade name for glyphosate (N-phosphonometnyl glycine). This chemical has been tested in the western United States since 1974. It is registered for both side preparation and release of conifers. It is not proposed for use in 1978, however it is projected for use on 12,887 acres in 1979 as part of the proposed action described in Chapter I.

Selectivity is based on timing, rate of application and coniferous species tolerance (O'Sullivan, 1977). Test results to date with the chemical have been erratic (Gratkowski, personal communication).

This product controls a broad range of herbacious and deciduous brush species. These include many grasses, forbs, fern, salmonberry, thimbleberry, vine maple, and other shrubs. The chemical is translocated to the roots and sprayed brush does not resprout.

Roundup appears to be a good replacement for Silvex in deciduous Coast Range brush and to be particularly effective on salmonberry in multistory alder-salmonberry stands. Roundup will not kill larger alder outright and may need to be used in combination with slashing or with 2,4-D applications.

The chemical appears to be mainly useful in the Northwest Coastal sub-biome. The chemical does not control evergreen brush and is not particularly useful on sclerophyll vegetation of the Montane Sub-biome. Roundup may prove useful against herbacious vegetation in this sub-biome however, as well as against certain deciduous species of brush. Field trials are needed before this can be substantiated.

Site disturbance from logging or some form of mechanical scarification immediately before application may prevent Roundup from being fully effective especially on resprouting brush. Apparently, site disturbance interferes with translocation of the herbicide. Precipitation soon after application will also greatly reduce the effectiveness of Roundup.

Roundup costs about three times as much as Silvex per gallon. It appears to be more effective on salmonberry than Silvex and may make resprays unnecessary.

Vegetation control appears to be very complete except that bigleaf maple and evergreen species are generally not affected. Conifers may be injured if Roundup is applied during periods when conifers are physiologically active. The chemical is not registered for planting site preparation in spring application.

Increased Use of 2,4-D

In some instances in the evergreen brush types of the Montane Coniferous sub-biome acceptable control can be achieved with two to four pounds of 2,4-D rather than with a mixture of 2,4-D and Silvex. The spectrum of control will be reduced however, and there may be a need for re-sprays. 2, 4-D and Silvex are not completely suitable replacements for each other. While there is some overlap in effect on many brush species, the two phenoxy herbicides complement rather than replace each other in silviculture. They are most effective if used in combination. 2,4-D does not provide adequate control for golden chinquipin and gives somewhat poorer control of snowbrush and varnishleaf ceanothus. 2,4-D will not control poison oak. 2,4-D is about half the cost of Silvex for an equal volume. Having to use more will make costs comparable. If re-sprays are needed, costs with 2,4-D alone will be corresponsingly increased. 2,4-D is more damaging to pines than Silvex.

An analysis of the environmental impacts of 2,4-D is fully described in Chapter III and will not be repeated in chapter VIII.

Tordon

Tordon is a restricted use nonselective herbicide which is available in liquid or pelleted form. It may be sprayed broadcast or used selectively by injection or by scattering pellets beneath individual plants. Tordon can be used for site preparation on areas occupied by deciduous woody plants,

but is not particularly effective on evergreen species except by injection (Gratkowski, 1978). Tordon gives fair to good control of bigleaf maple and chinkapin in injection treatments. Season of treatment is important (Newton, 1978). Tordon may be used to treat hardwoods prior to or after logging to prevent sprouting. Chinkapin often exists as small plants which are not treatable by injection, but which are released by logging and grow to become severe competition to planted conifers. Foliar treatments of these small plants with Tordon is not effective.

Triclopyr

Triclopyr (3,5,6-trichloro-2-pyridinyloxy acetic acid) is a new chemical not currently registered for forestry use which holds some promise as a site preparation tool. The chemical is nonselective. It may be formulated as an amino salt or as an ethylene glycol butyl ether ester, under the trade name Garlon. Triclopyr controls both deciduous and evergreen brush species. It appears to give good initial control of golden evergreen chinkapin, salmonberry, vine maple and California Hazel, but resprouting will occur. No data is available for golden chinkapin. Triclopyr damages conifers and, if registered, should be used only for site preparation (Gratkowski and Stewart, 1978) (Gratkowski, 1978).

The following table summarizes potential replacements for Silvex by target species:

Table A Potential Substitute for Silvex

Target	2,4-D	Krenite	Roundup	Picloram	Triclopyr*
Vine Maple		Fair-site prep. Poor-release	Good-site prep. Fair-release	Very good-site prep. only	Good-site prep. only
Bigleaf Maple	—	—	—	Good-by injection only	Unknown
Snowbrush	Fairly good	—	—	—	Unknown
Varnishleaf	Fairly good	—	—	—	Unknown
Golden Chinkapin	—	—	—	Fairly good-by injection only	Good-site prep. only-or by injection or directed spray
California Hazel	Poor-unless combined with Dicamba for site prep.	Fair-site prep. Poor-release	Good	Good-site prep. only	Good-site prep. only
Poison Oak	—	—	Unknown	Good-site prep. only	Unknown

* not yet registered for forestry use.
— means "no or little effect".

Definitions

Good - 100 percent control of target species for at least one growing season.
Fair - 50 to 75 percent control of target species for at least one growing season.
Poor - less than 50 percent control of target species for one growing season

Comparative Costs

The following table summarizes the treatment costs for a mix of 2,4-D and Silvex and for the various substitute mixes which would be required if Silvex was not used. Costs for proposed FY 78 projects that require the use of Silvex would rise by 210 percent from $771,934 with Silvex to $1,624,919 with the substitute treatments.

Table B Relative Treatment Costs Per Acre

Method	Application	Chemical	Total
1 lb. 2,4-D and 1 lb. Silvex	$10.50	$ 6.50	$17.00
3 lbs. 2,4-D	10.50	6.00	16.50
with one repeat	22.00	12.00	33.00
Krenite (release) (one gallon)	10.50	32.00	42.50
Krenite (site prep.) (two gallons)	10.50	64.00	74.50
Roundup (release) (1 quart)	10.50	13.00	23.50
Roundup (site prep.) (2 quarts)	10.50	26.00	36.50
3 lbs. 2,4-D and Roundup (release)	23.50	16.50	40.00
Roundup (3 quarts)	10.50	39.00	49.50
Tordon Injection	40.00	5.00	45.00
3 lbs. 2,4-D	45.00	16.50	61.50

Potential Alternatives to the Proposed Use of Silvex in 1978

Currently feasible chemical alternative to Silvex treatments proposed in 1978 are shown in the following tables. If alternative A was adopted, chemical alternatives to Silvex would be prescribed in lieu of Silvex for vegetation control programs proposed from 1978 through 1987.

Table C

District: Roseburg

Silvex Replacements

Treatment Number	Target	Purpose	Original Mix	Substitute
100-9	Madrone Chinkapin	Release	2,4-D, Silvex	3lbs. 2,4-D, inject Chinkapin
100-10	Madrone chinkapin	Release	2,4-D, Silvex	3 lbs. 2,4-D, inject Chinkapin
100-14	Madrone chinkapin Poison Oak	Release	(over pine) Silvex (tall)	Inject madrone Chinkapin with Tordon
100-15	Big leaf Maple	Site Prep.	Silvex Basal Treatment	Inject or cut surface treat with Tordon or use pellets

Table C

District: Salem

Silvex Replacements

Treatment Number	Target	Purpose	Original Mix	Substitute
1	Alder, Vine maple, Blackberry	Road Maintenance	2,4-D, Silvex	Banvel 720 (Dicamba & 2,4-D) or Roundup, Krenite.
3	Alder, Vine maple, Bigleaf maple.	Release	2,4-D, Silvex	Tordon injection combined with 2,4-D in diesel or Roundup.
6	Bigleaf maple	Site prep.	Silvex, basal treatment	Tordon injection or cut surface treatment.

Table C

District: Eugene

Silvex Replacements

Treatment Number	Target	Purpose	Original Mix	Substitute
6	Vine maple, Hazel, Alder, Ceanothus	Site prep. & release	Silvex, 2,4-D	Roundup. Use 2,4-D on Ceanothus
11	Maple, stump sprouts	Release	Silvex (manual)	Tordon injection or cut surface

Table C

District: Coos Bay

Silvex Replacements

Treatment Number	Target	Purpose	Original Mix	Substitute
1	Alder, Vine maple, Hazel	Release	2,4-D, Silvex	Roundup
4	Thimbleberry, Salmonberry	Release	Silvex	Roundup or Krenite
5	Bigleaf maple, stump treat & sprouts	Release	Silvex	Tordon, injection or cut surface

Table C

District: Medford

Silvex Replacements

Treatment Number	Target	Purpose	Original Mix	Substitute
5, 6	Ceanothus, Chinkapin, Willow	Release	2,4-D , Silvex	Use 2,4-D in diesel, inject Chinkapin with Tordon.
7	Vine maple, Deerbrush, Hazel Cherry	Site Prep.	2,4-D, Silvex	Roundup, or 2,4-D may be needed to get Deerbrush--use diesel carrier, Tordon good if no stocking need be saved.
9	Madrone, Live Oak, Hazel	Site Prep.	2,4-D, Silvex	2,4-D will get Madrone and Live Oak; if necessary to control Hazel use Roundup in separate application.
10	Vine maple, Deerbrush, Hazel, Cherry	Site Prep.	See 7	See 7
13	Chinkapin, Madrone, Snowbrush,	Release	2,4-D, Silvex	2,4-D at 3 lbs. per acre. Inject Chinkapin with Picloram
14	Madrone, Manzanita, Alder, Hazel	Release	2,4-D, Silvex	Use 2,4-D in diesel. If Hazel a problem use Roundup in a separate application.
16	Madrone, Alder, Manzanita, Ceanothus	Release	2,4-D, Silvex	Use 2,4-D in diesel carrier-use oil/water if Alder not important.
18	Ceanothus	Release	Silvex	Use 2,4-D in diesel for Deerbrush. Use water/oil emulsion for Varnishleaf and Snowbrush.
19	Tan oak, Live Oak, Manzanita, Madrone	Release	2,4-D, Silvex	Use 2,4-D in water/oil emulsion.

Table C

District: Medford (Continued) Silvex Replacements

Treatment Number	Target	Purpose	Original Mix	Substitute
20	Hazel, Vine Maple ribes	Release	2,4-D Silvex	Roundup Krenite
21	Ceanothus, Chinkapin, Tan Oak	Release	2,4-D Silvex	2,4-D. Inject Chinkapin with Tordon.
22, 23	See 21	See 21	See 21	See 21
27	Tan Oak, Salal, Manzanita, Rhodo-dendron, Chinkapin, Ocean Spray	Site Prep.	2,4-D Silvex	2,4-D. Inject Chinkapin.
28	Live Oak, Chinkapin, Tan Oak	Basal treatment (Fall)	Silvex	Use 2,4-D, amine or Tordon.
30, 31	Manzanita,	Release	2,4-D	Use 2,4-D, inject Chinkapin
32, 33	Tan Oak, Salal, Chinkapin, Ocean spray		Silvex	Picloram.

Environmental Impacts

The subsequent discussion describes the environmental impacts that may differ from those described in Chapter III and are associated with substituting other chemical herbicides for Silvex in the vegetation control program described in Chapter I.

Vegetation

Impacts to vegetation from the non-silvex chemical alternatives do not differ materially from the impacts identified for the proposed action. Timber yields would not decline. However, if funding levels are not increased to cover the additional costs incurred in this alternative, timber yield would decline markedly.

In the non-silvex alternative vegetative seral changes will not differ from the proposed action. Changes in the spectrum of control will effect the species mix remaining after treatment. Repeat sprays with 2,4-D will have a narrower spectrum of control than 2,4-D and Silvex combined, but Roundup will have a broad spectrum of control. A certain hazard to vegetation would be incurred in using herbicides such as Krenite or Roundup which lack extensive field use. Since repeat sprays will be needed with 2,4-D, the chance of damaging non-target plants from drift is increased. The chance of damaging pines will be increased through the use of 2,4-D and hemlock may be damaged by Krenite and Roundup.

Resprouting of brush will be increased for some spray combinations and decreased for others. Roundup and Tordon will particularly reduce sprouting, while 2,4-D will increase sprouting for some vegetation. Poorer control with 2,4-D will result in more vegetation flagging-out with foliage on existing stems within one year after treatment.

Increased frequency of herbicide application in this alternative, and the use of broad spectrum chemicals such as Roundup could have a greater impact on non-target vegetation that is inadvertently treated such as rare and endangered plants.

Wildlife

Impacts to wildlife as a result of the proposed no-silvex alternative differ from the proposed action. TCDD (dioxin) contained in Silvex as a contaminant will not be introduced to wildlife through the food chain.

Other impacts relating to chemical toxicity and habitat impacts are not known to be materially different from those described in Chapter III.

Soil

Impacts to soils as a result of the proposed no-silvex alternative will be essentially as described in Chapter III except that TCDD (dioxin) clinging to soil particles will not be available for overland transport to water courses.

Aquatic Organisms

Impacts to aquatic organisms as result of the proposed no-Silvex alternative differ from the proposed action. TCDD (dioxin) will not be introduced into the aquatic ecosystem. The toxicity of alternative chemicals such as Roundup and Krenite to fish is less than Silvex as illustrated in Chapter III.

Water

Impacts to the aquatic water resource as a result of the proposed no-Silvex alternative differ from the proposed action. TCDD will not be introduced into water systems. Other impacts are essentially unchanged from those described in Chapter III.

Visual Resources

Visual resource impacts as a result of the proposed no-Silvex alternative are essentially the same as described in Chapter III.

Human

Potential for adverse impacts to human health as a result of the TCDD contaminant in Silvex and the toxicity of Silvex will be eliminated as a result of the proposed no-Silvex alternative.

Energy consumption manifested by the use of diesel oil herbicide carrier will be reduced by 90,000 gallons.

Sensitive Areas

The impacts of the proposed no-Silvex alternative on adjacent agricultural land, residences, and downstream water users are not expected to differ materially from those described in Chapter III.

Cumulative Impacts

The "no-Silvex" alternative eliminates the possibility of the accumulation of associated TCDD in the environment as a result of the proposed use of herbicides described in Chapter I.

Conclusions

Environmental impacts of the proposed no-Silvex alternative that differ from those described for the proposed action in Chapter III are reflected mainly in the elimination of the possibility of introducing TCDD (dioxin) into the environment through the use of Silvex.

The cost of vegetation control with Silvex substitutes is about 2.1 times the cost of control with Silvex

VEGETATION MANAGEMENT WITHOUT CHEMICAL HERBICIDES

(Alternative B)

This alternative explores the feasibility of increased use of the non-chemical vegetation control methods now used by the Bureau. These include; mechanical, controlled burning, manual and biological.

Analysis Method

The non-chemical methods described above are analyzed for impacts separately for each environmental component that may be significantly impacted. The Bureau currently uses these methods to the extent described in Chapter I. Mitigating measures to protect the environment when non-herbicidal methods are used are described in the Environmental Assessment Record, "EAR", prepared by individual districts for each proposed vegetation control project. These measures include buffer strips alongside streams, season of operation limitations, smoke management restrictions and soil management requirements. Therefore, this analysis focuses only on the practicality and potential for using non-herbicidal methods on areas where vegetation control with herbicides would normally be proposed as the most desirable vegetation management alternative.

Conclusions drawn from the analysis are presented at the end of the discussion of each environmental component that may be impacted.

VEGETATION

Environmental impacts of mechanical, controlled burning, manual and biological vegetation control on vegetation are described below.

Mechanical

A part of the proposed action suggests the use of herbicides for the "release" of conifers on 45,706 acres in 1978. Mechanical "release" with machines is impractical because it would tend to remove many of the "non-target" conifers that are interlocked with unwanted vegetation. In essence, the size of the equipment (10-14 feet in width) makes most mechanical treatments unfeasible. Machines are also limited to operations on gentle topography where the dangers of tipping over and sliding out of control are minimized. Many of the areas requiring "release" control are on topography much too steep for most machines.

Herbicides are proposed to control noxious plants on 200 acres in 1978. The acreage figure represents a summary of scattered treatment areas consisting of various size patches of Tansy Ragwort. Movement of machines to each treatment location to dig out or cut these plants is impractical.

The maintenance of improvements is proposed with herbicides on 2,545 acres in 1978. This work is principally roadside vegetation control. Machine treatment is feasible on most of this area. Experience with machine

cutting has led to current proposals to use herbicides because of recurrent sprouting of cut brush. Sprouting results in multiple stems, especially for species like Alder and Maple, which create a compounding of road related problems such as the loss of visibility on turns, loss of road shoulders, narrowing of driving lanes and an increase in the vegetation control work load and attendant costs.

Site preparation is proposed with herbicides on 25,876 acres in 1978. The proportion of this area that is on topography that is too steep for most machine operations has not been determined. However, assuming feasibility, the impacts of machine site preparation on unwanted vegetation are dramatic. Above ground portions are usually destroyed. Planting large conifer seedlings in machine prepared areas can result in good plantation success in some areas.

On an area that is machine cleared, all or nearly all surface vegetation is removed. Clearing costs may be reduced if tractors are kept moving forward, rather than attempting complete eradication (Gratowski, 1967). However, partial scarification has proved less successful than more complete mechanical disruption for attaining bare soil conditions. Within a year, the area is covered with vegetation that sprouts from roots or develops from the seeds of early seral annual grasses and weeds (Newton, 1967). In a review of Roseburg and Medford District reforestation projects in 1964, Newton (Newton, memo) pointed out atrazine treatment was resulting in plantation success on areas which had failed when planted after scarification alone. Follow up

treatments with herbicides were clearly necessary if planted conifers were to survive on these areas.

In a recent study (Dimick et. al) comparing results of various stand conversion methods it was found that tractor scarification produced the widest range of results in terms of conifer stocking. Variation in aggressiveness of brush and problems with tree-damaging animals may account for these differences.

Costs of machine site preparation may range from $100.00 to $600.00 or more per acre.

Controlled burning

Controlled burning is useful as a single tool or in combination with other methods for site preparation. It is not practical for release, maintenance, or noxious plant control. Controlled burning includes broadcast burning, where all vegetation, debris, and soil litter is burned over on a total area, and selective burning to remove concentrations of vegetation and debris resulting from mechanical and hand piling or from logging. It is a feasible alternative to that portion of the 25,876 acres proposed for herbicide site preparation in 1978 that has vegetation or slash that is in adequate quantities and condition for burning.

Fire can provide a fast method of site preparation. A harvested area can be burned in a very short period of time, often less than a day. Easy planting spots are available if mineral soil is exposed, but shade from slash or brush that is needed for seedling survival on hot dry slopes may be removed. Surface vegetation growing on the site is removed, but resprouting of brush from roots may occur the first year. An excellent seedbed for grasses and forbs is created, sometimes necessitating followup applications with grass control chemicals if planted conifers are to survive. The brown and burn technique is only applicable in brushfields where the brush is less than 20 feet tall. In stands over 20 feet tall, two problems limit the use of this technique: (1) the brush canopy will not allow penetration of the herbicide to the shorter brush species and (2) fire will not adequately consume the brush. The method is proposed for use on 975 acres in 1978.

The number of days when fire can be used safely and effectively is limited by weather conditions, fuel conditions, and "smoke management" restriction. Current "smoke management" policies require burning only when smoke will be dispersed rather than settling in the valleys. Sudden changes in weather conditons or improper burning can produce too hot a fire and cause undesirable results. These include damage to the topsoil, fire escapement, and setting back the successional cycle more than desired. Vegetation control on some harvest units is often delayed 2 to 3 years before suitable conditions exist for burning the logging slash. When this point is reached, more often than not, a decision is made not to burn because conditions have changed to the point where the hazard has been reduced by slash decay.

However, by this point in time reforestation success is seriously impaired because competing vegetation is well advanced , burning is no longer feasible, and herbicides or some effective treatment method is required to obtain successful reforestation.

The Bureau requires its timber sale purchasers to burn their logging slash in order to reduce the fire hazard. Coincidentally, this action can often produce a good tree planting site because competing vegetation has been destroyed or set back in growth. Unfortunately, the required burning is rarely accomplished in a timely or diligent manner and sometimes not at all. In 1976 only 68 percent of the area scheduled for slash burning was successfully burned.

Recently, the Bureau's Oregon State Director executed an agreement with the State of Oregon that permits state fire protection associations to do some controlled burning on Bureau-administered lands where necessary. In Oregon, the Bureau is also about to embark on a strengthened program of required burning by timber sale contractors.

A potential does exist for more vegetation control with burning. This can be achieved by increasing the success rate for planned treatments. If 100 per cent successful, an estimated additional 8,000 acres could be treated annually in lieu of an initial herbicide treatment. This represents 35 per cent of the total acreage proposed for herbicide treatment as a site preparation measure in 1978. Costs of burning range from $25.00 to $150.00 or more per acre.

Manual

Manual methods of vegetation treatment take many forms. All of them are more costly than herbicides.

Without considering costs, effectiveness, or the availability of dependable labor it is physically feasible to attempt manual vegetation control on all the acreage (74,436 acres) proposed for treatment annually with herbicides. Hand site preparation and release has been attempted on forest land in Western Oregon. In the summer of 1977, the Siuslaw National Forest attempted hand release on new plantations. All contract work defaulted because the contractors discovered they could not make a profit at the prices they bid. Forest service crews treated several hundred acres at costs ranging from $25 to over $100 per acre. The treatments were judged to be highly selective and useable in sensitive areas, but problems occurred from damage to conifers during cutting, resprouting, accident potential, and other factors (Turpin, 1977). A hand brush control project in the Roseburg District, recently advertised, received only one bid which was finally negotiated at $420.00 per acre for cutting and $195.00 per acre for piling and burning. In its Delezene Plantation Management Study, Weyerhaeuser Company found that yearly hand weeding of seedlings combined with atrazine herbicide applications was superior to irrigation or fertilization in guaranteeing 5 year survival and growth of Douglas-fir seedlings (Woodman, unpublished). Lewis and Higdon (1977) reported that on the Roseburg BLM district brush cutting for release was not just expensive and ineffective, but damaging to the conifer crop. Cutting of competing

hardwoods resulted in mechanical damage to conifers from wind and snow. Severe sun-scalding also occurred. Both diameter and height growth were greater on sprayed than on brush cut areas. Diameter growth was increased by hand release, but height growth was severely reduced. Resprouting of sclerophyllous hardwoods occurs regardless of the season of treatment. The damage of hand release may be partially offset by fertilization. Brown (1977) found that hand brush cutting in Josephine County cost $556. to $1,269. per acre. An extreme slash hazard was created. Standing dead brush is less of a hazard than cut brush.

The impact of hand cutting on vegetation is generally highly transitory. Most species resprout and will continue to dominate the site. Some species, such as hairy manzanita do not resprout. Small conifers or non-target plants are crushed by falling brush. Damage to conifer stands from hand release may retard the establishment of conifer dominance.

Several studies have shown that mulching with paper or plastic increases conifer survival. However, unshaded mulch can be detrimental to seedlings if surface temperatures are high. Cost and logistics of mulch placement limit the practical use of mulch on most sites (Cleary, Greaves, and Hermann, 1978). Hunt (1963) reported that any opaque mulch material at least 2 feet square is effective in increasing plantation survival. Hermann (1964) reported that paper mulch significantly increased survival on the Medford, Roseburg, Coos Bay, and Eugene BLM districts. Sheets placed on slopes have a tendency to slide downhill even if weighted down. Schaefer and Lewis (1978)

working with plastic mulch at Roseburg BLM district found that installation cost of plastic mulching averaged $331.48 per acre. This compared unfavorably with costs of $27.25 per acre obtained with application of atrazine and dalapon herbicides. Despite attempts to pin plastic to the ground approximately 34% of the treated seedlings were pulled over by downslope movement of the plastic or the anchoring material. Another 16% of the seedlings were improperly mulched or damaged by installation despite supervisory and inspection efforts. Working on BLM land in Medford District, Edgren (personal communication) found that plastic mulching did not give survival rates as good as that attained by herbicide application.

Conifers growing in a suppressed or overtopped condition suffer wind and snow damage when overtopping vegetation is controlled through manual methods. The shock effect of sudden exposure is related to the degree and length of time the trees have been suppressed. On the other hand, thinning conifer stands mainly involves the removal of suppressed trees and reservation of the dominant trees. Therefore, the shock of sudden exposure to crop trees is limited. Most deciduous species that are cut will quickly resprout from the crown area around the base or lower branches if they remain. Grasses tend to rapidly reinvade areas of exposed mineral soil.

Hand scalping vegetation (manual removal with hoes) to prepare planting spots will not by itself produce adequate site preparation. In a study on BLM land near Butte Falls, Oregon (broad sclerophyll sub-biome), scalping and plastic mulching increased survival of planted seedlings by about 70 per

cent (Edgren, personal comm.). It is most effective in newly established grass cover and less effective in well established grass and shrub cover (Stewart, 1976). Small scalps probably provide little or no relief from moisture competition. Hall (1971) found that scalped spots had to be at least four feet in diameter to establish Ponderosa pine on the Idaho batholith. In many cases scalping has no effect on survival and only serves to increase the cost of the plantation (Newton, 1967).

Fire hazards are created by the piles of cut material depending on the amount and distribution.

Manual control of unwanted vegetation to the extent necessary to reach the objectives set forth in Chapter I will undoubtedly require several successional treatments of the same area in order to handle recurrent sprouting of brush and hardwoods and invasion from prolific seeders such as grass and Alder. Little actual experience is available to indicate that the objective can be met when manual methods alone are employed at the scale necessary to achieve the vegetation management objectives required.

Biological

A problem with biocontrol is that most brush species are native. A native plant population already has a natural predator complex, as well as many other regulating factors, and in an ecological sense is already under a type of control. Biocontrol has been directed almost exclusively at introduced

plants that frequently become weeds because they lack natural predators. Existing biocontrol efforts are centered on introducing predators into areas recently colonized by their host plants, since generally the weed-predator complex in the native complex does not allow the weed to reach pest status. This approach has been, on occasion, highly successful.

Tansy ragwort, a Pacific Northwest resident for more than 50 years, has become a serious agricultural problem in western Oregon and Washington. Tansy has spread on cutover forest lands, pasture and rangelands and roadsides. The spread has become more rapid in recent years due to soil disturbance associated with man's activities in an ever-expanding economy. This weed is believed responsible for more livestock losses in Oregon than all other poisonous plants combined.

Of the known control methods for Tansy (chemical, mechanical and biological), it appears that a biological control technique using insects will eventially provide the greatest opportunity for mitigation of the effect and spread of the weed.

During the past three and one-half years, as a result of a coordinated statewide cinnabar moth larvae release program, several hundred new colonies have been etablished. We plan to continue to participate in this program within the limits of available resources. During the 1974 and 1975 field seasons, 85 cinnabar moth colonies of approximately 1,000 moth larvae each were released on public lands in the Salem, Roseburg, Eugene and Coos Bay districts. During the past field season (1976), 54 new releases were made.

Flea beetles, another biological control agent of tansy, were released at 16 sites during 1976. A total of 12,500 beetles were liberated on BLM administered lands.

Two releases of tansy ragwort seedfly were made on lands in Clackamas and Polk counties.

Present surveys indicate that cinnabar moth colonies have been successfully established (survival over one year or more) on 78 townships containing BLM admiistered land.

A two-year contract for the biological control on tansy was signed on March 26, 1976, with the Oregon Department of Agriculture.

It became apparent during the 1976 field season that there are situations where biological control techniques cannot be effectively implemented; for example, small infestations of tansy associated with clearcuts and roadside disturbance areas. In these situations there is not enough target vegetation to support a viable colony of the insect.

In view of this, the Bureau has modified its contract with the state to provide for a limited amount of chemical and hand control measures to be undertaken in situations where effective biological control cannot be implemented.

Early evaluations of 1976 releases indicate that releases are proving to be quite successful, but total evaluation must be made for a true picture of the results of last year's work. Establishment of the 1976 flea beetle release also looks good.

Livestock have been used as a form of biological control to reduce vegetation. However, livestock are usually excluded from reforestation areas in an effort to reduce damage to seedlings from browsing and trampling. The use of sheep to control undesirable vegetation is being studied on the Umpqua National Forest. A reduction of palatable plants and some soil compaction in bedground areas occurred. There was little or no damage to conifers by the sheep. Although it is presently uncertain as to just how much vegetation control was accomplished, the study will be continued through a cooperative study with Oregon State University in a plant utilization study. At the same time the Siskiyou National Forest is evaluating the use of goats to control vegetation.

The following are additional examples of insect predators and their host plant species.

(1) The California tortoiseshell butterfly, Nymphalis californica, a feeder on varnishleafed ceanothus.

(2) A flea beetle, Altica carduorum, on Canadian thistle.

(3) A moth, Leucoptera spartifoliella; and a weevil, Apion fusccirostre, on Scotch broom.

(4) The western tent caterpillar, Malacosoma plurialis, a feeder on foliage of red alder.

(5) Oystershell Scale, Lepidosaphes ulmi on willow and snowbrush ceanothus.

(6) Ceanothus Tingid, Corythucha obliqua on snowbrush ceanothus.

(7) Ceanothus Psyllid, Euphalerus vermiculosos on snowbrush ceanothus.

(8) Oals P.T. Scale, Asterolecanium minus on Canyon Live Oaks (Compton, 1977).

Extensive testing is necessary to assure that a potential biological control agent is specific to the target organism and won't do more harm than good.

The impact on riparian vegetation and rare and endangered plants would be the most serious problem with biological control. Control of the biological agent once it is released is difficult. If aquatic vegetation is included in the diet of the biological agent there will very possibly be heavy damage to those plants.

Cumulative Impacts

Cumulative impacts to vegetation as a result of effective non-herbicidal vegetation control will lead to a shortening of the seral stages in natural succession and earlier dominance by the desired conifer species on a portion of the treated area. Total vegetation control with non-chemical methods will be successful in accomplishing current timber management objectives on only a portion of the total area needing treatment. Timber production will be reduced from levels possible with complete vegetation control. Quantification of the loss in timber production and the failure/success ratio on treated acres is not possible with information currently available.

Conclusion

The following impacts to vegetation may occur during the use of non-chemical control methods:

1. Riparian vegetation will be inadvertently damaged. The greatest risk is associated with biological control and the least risk with manual control.

2. Treated vegetation will regenerate through sprouting and seeding.

3. Conifers will be damaged in some areas and increase in survival and growth on other areas.

4. Costs of treatment will range from $25.00 for control by burning to $1,300 per acre for manual vegetation control.

5. Non-target plants such as rare and endangered species and adjacent agricultural crops will inadvertently be damaged. The greatest risk is from fire and/or biological and the least is from manual control.

Terrestrial Wildlife

Environmental impacts of mechanical, controlled burning, manual and biological control vegetation control methods are described below.

Mechanical

The impacts to wildlife caused by site disturbance through mechanical means has received little study. Generally, for all species, there will be a severe temporary dislocation after which species associated with the seral community will return, as natural succession provides habitat.

Mechanical control of vegetation reverses or retards plant succession. Young et al (1967) found that forage and browse production was increased due to logging or mechanical site distrubance. Carter and Kennormer (1975) conclude that intensive mechanical site preparation is much more destructive to wildlife forage production when compared with chemical site preparation because the chemicals do not kill as much vegetation.

However, subsequent regrowth of vegetation from remaining root systems will eventually increase browse for deer and elk.

The noise level associated with machine clearing will cause some animals to move away temporarily from the area undergoing treatment. The abundance and divserity of birds located in the treatment areas will decline as they move out to find substitute habitat with adequate food and cover. Animals most adversely affected by mechanical operations include the burrowing forms and those with low mobility. In many cases the unburned or paritally burned piles of brush can create desirable habitat for mountain beavers, rabbits, and rodents that are prone to feed on planted seedlings.

Burning

The most important impact results from changes in vegetative structure, diversity and cover characteristics (Martin, Cooper, Craw, Cummings, Phillips 1976, Bunnell and Eastman 1976). Like mechanical methods, controlled burns retard plant succession. Generally, controlled burning is considered beneficial to vegetative species composition. Likewise, the resprouting vegetation is favorable for browsing animals but may be unfavorable for others (Martin, Cooper, Craw, Cumming, and Phillips, 1976). Black tailed deer and elk are benefitted through the use of fire-dependent browse species such as fireweed, (Epilobium sp.) wedgeleaf and redstem ceanothus, (Ceanothus sp.) resprout quickly.

Burning impacts on wildlife varies by species. Many mobile species such as birds can flee fire. Small mammals, amphibians and reptiles are less mobile and thus are severely impacted. Weyerhaeuser Co. (1977) indicates

that 50 per cent of mountain beaver on burned areas are killed. In forest management this loss of mountain beavers through burning is viewed as a beneficial method to control animal damage to planted conifers. Hooven (1969) found that after fires, deer mouse populations were depressed, however, populations recovered rapidly shortly thereafter. Several authors have reported that shrews are nearly eliminated for several years after burns. Hager (1960) reported that burning slash may reduce the habitat of such birds as the Oregon juncos and winter wrens. These birds use slash piles for perches and escape cover.

In a burned area the effect on wildlife is a temporary loss of food. Usually grass and browse species resprout within a few months because the roots are not destroyed by fire.

During controlled burns snags are either burned or removed to reduce the chances of fire spreading. This loss of sncgs represents a reduction of habitat to cavity dwelling wildlife.

Unburned logging slash on some sites can impede the movement of big game animals. As a result they may avoid using such areas.

Manual

Little research has been done on the effects of large scale manual vegetation control and wildlife populations.

Browse for deer and elk will increase as a result of the sprouting that commonly occurs after manual cutting of vegetation. However, areas of thickly matted cut vegetation could severely restrict movement of big game through the area. Some wildlife escape cover will be eliminated for a period of time. Bird habitat and food sources may be reduced or modified.

Biological

The feasibility of biological control much beyond the control of Tansy ragwort with the Cinnabar moth is doubtful. Tansy is not an important species for wildlife cover or food.

The alternative of grazing by cattle, sheep or goats on some areas normally proposed for herbicide treatment does exist but on a limited scale. In these instances it is likely that food and cover normally used by wildlife in the project area will be occupied by the domestic animals.

Cumulative Impacts

Wildlife habitat and food supply will be altered as a result of non-herbicidal vegetation control methods. The cumulative impact is the shortening of the seral vegetation stages on the treatment areas and the dominance by conifers at a rate sooner than natural succession. As a result wildlife diversity and numbers will be reduced.

Non-herbicidal vegetation control methods will:

1. Increase food for big game as a result of the sprouting of treated vegetation.

2. Reduce habitat for snag dwellers.

3. Reduce the numbers of wildlife such as reptiles and mountain beaver found on an area prior to burning.

4. Restrict movement of big game through some areas because of the heavy accumulation of slash on the forest floor.

5. Reduce total wildlife diversity and numbers.

Soil

Environmental impacts of mechanical, controlled burning, manual and biological methods of vegetation control on soil are described below.

Mechanical

Scarification for brush removal and its subsequent piling by crawler tractors, even when especially equipped with "brush" blades, strongly conflicts with prudent soil management because of incipient compaction and the high

percentage of organic litter and vegetative cover removed from the soil surface. This increases the susceptibility for soil erosion by raindrop splash and surface runoff.

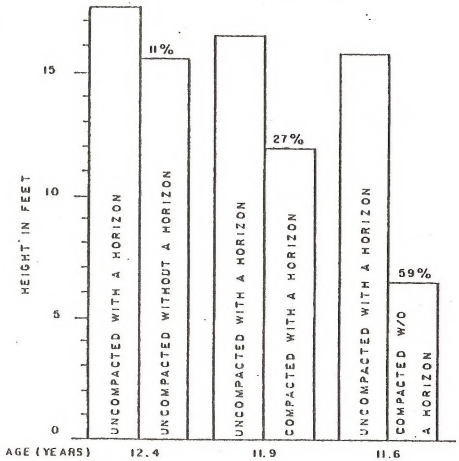
In addition, in the process of bunching this material into piles, there is a severe hazard of removing some or all of the soil surface horizons where a larger proportion of the nutrient capital exist. This will create nutrient deficiencies between the piles and reduce the ability of the site to adsorb and biodegrade chemicals due to removal of organic matter and the attendant drastic reductions in numbers of soil organisms which live there.

Soil compaction, particularly around each bunched pile, is a serious problem on soils with more than 18 per cent clay. Compaction reduces productivity by restricting water infiltration, root penetration and elongation, and gaseous exchange within the root zone.

The following bar graphs illustrate both the importance of the nutrient rich surface horizons and the impact of soil compaction or plant growth. These data represent two extensive soils found in the Northwest Coastal Coniferous Forest sub-biome.

Piling operations can be acceptable, although not the most desirable, providing slopes are less than 35 per cent, dry soil conditions exist, the proper equipment is used, and the soil is not significantly displaced while adequately ripped to ameliorate compacted conditions.

FIGURE 7 COMPARISON OF TREE GROWTH AS AFFECTED BY THE REMOVAL OF THE A HORIZON AND COMPACTION KEEL SERIES 1/ SALEM BLM 2/

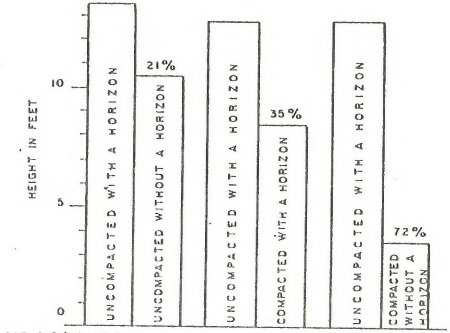


% IS THE PERCENT REDUCTION IN GROWTH

1/ A loamy textured soil in the Udic-cryic Climatic zone.

2/ Unpublished soil Data, Salem District BLM.

FIGURE 8 COMPARISON OF TREE GROWTH AS AFFECTED BY THE REMOVAL OF THE A HORIZON AND COMPACTION
McCULLY SERIES 1/
SALEM BLM 2/



% IS THE PERCENT REDUCTION IN GROWTH

1/ A fine texture soil in the Udic-mesic Climatic zone.

2/ Unpublished Soil Data, Salem District BLM.

Subsequent to the piling operation, the disposal of piled material by burning creates hotter fires than broadcast burning and thus adversely affects the soil.

Controlled Burning

Burning has a tendency to bare mineral soil thus increasing the hazard for accelerated erosion for the following reasons: The creation in certain soils a water-repellency layer at the soils surface due to release of hydrophlbic gases during combustion of the organic matter which then coat soil aggregates encouraging runoff (De Bano and Rice, 1973); breakdown of water-stable soil aggregates may be reduced in number and size, with severe hot fires, presumably by losses of associated organic colloids (Dyrness, et al, 1957); and the removal of the duff and litter layers leads to raindrop splash erosion during the winter months and ravel erosion in the hot summer months on steep slopes until vegetative cover is re-established.

Other disadvantages to burning would be the reduction in moisture-holding capacities in the top few inches of mineral soil (Neal, et al, 1965). The release of nitrogen (De Bell and Ralston, 1970), sulfur (Allen, 1964), and phosphorus (Grier, 1972), may, depending upon the intensity of the fire, be volatized into the atmosphere. The released cations may be rapidly lost by leaching in the absence of organic colloids, and tightly bound water in expanding clay lattice structures (montmorilloritic) may permanently lose their capacity to expand and contract thereby assuming the moisture characteristics of sand and gravels (Ralston and Hatchell, 1971).

Burning, other than providing site preparation for planting, does temporarily reduce soil acidity by the release of calcium, potassium, etc., which in turn increases the short-term availability of such mineral nutrients as phosphorus which collectively stimulates a quick flush of vegetative regrowth. The nutrients not utilized by plants may be lost by leaching or erosion processes.

Controlled burning, to be successful, must only be prescribed on slopes and soils where burning under optimum climatic and fuel conditions will minimize the potential for adverse impacts to the soils on the site. Quantifying that portion of the acreage proposed for site preparation in 1978 (25,876 acres) that meet these criteria is not feasible.

Manual and Biological Methods

The impact of manual and biological vegetation control methods is expect expected to have little significant impact on the soil resource.

Cumulative Impacts

Long term productivity of forest land may be reduced as a result of erosion and soil compaction in some areas where fire or mechanical vegetation control methods are used.

Conclusions

Impacts to the soil resource can be severe in some areas if mechanical and controlled burning are used to control competing vegetation. Manual and biological methods will have no significant impact.

Specific Impacts:

1. Soil erosion will occur on burned and cleared areas.

2. Soil compaction will occur that will reduce conifer growth on cleared areas.

3. Reduction in soil moisture holding capacity will occur on burned areas.

Aquatic Organisms

Environmental impacts of mechanical, controlled burning, manual and biological control of vegetation on aquatic organisms are described below.

Mechanical

Mechanical vegetation control where physically feasible for site preparation will impact the aquatic ecosystem where such control takes place

within the riparian zone that adjoins drainage channels. The impact could be considered severe in the area where it occurs because riparian vegetation is virtually totally removed when machine control is used. The importance of this vegetation and guidelines to manage it are currently being developed by the Bureau.

The ripple effect of riparian zone damage will be felt throughout the aquatic ecosystem in the impacted area. Shade vital to maintaining cool stream temperatures required by trout and other aquatic organisms could be removed.

Controlled Burning

Soil erosion from burned areas on steep ground may cause sedimentation and increase turbidity in adjacent streams (Swanson 1971). Riparian habitat damaged by any method including controlled burning used for site preparation could result in stream temperatures that exceed the limit for survival of juvenile and mature trout and salmon. This has been documented in the Oxbow burn wildfire in the Coos Bay District by the Oregon Department of Fish and Wildlife (Anderson 1976).

It is common for debris (root wads, cull logs) to roll downhill in burned areas. On occasion they enter the stream channel. This happened extensively in the Oxbow burn wildfire where some streams were cleared of such debris several times (Coos Bay District BLM). Depending on the size of

the stream and the debris, fish migration may be obstructed. Streamside unburned bufferstrips are established during controlled burning operations to protect riparian vegetation which can then act as a filter. Normally, riparian habitat is difficult to burn. However, it is not uncommon to lose some buffer trees to burning where the fire escapes fire lines.

Manual

Manual cutting of vegetation may impact aquatic vegetation and dependent aquatic organisms when the riparian zone is included in a vegetation control project area.

Biological

Biological control methods could adversely impact riparian zones because of the lack of explicit control on where these biological agents (animals, insects, etc.) would feed.

Cumulative Impacts

Riparian habitat that is important to the equatic ecosystem may be damaged by all non-herbicidal control methods. Cumulative impacts may be felt throughout the aquatic ecosystem. Quantification of these impacts is not possible at this time.

Conclusions

Possible impacts to the aquatic resources from non-herbicidal vegetation control methods are:

1. Damage to riparian habitat and related aquatic organisms.

2. Sedimentation of stream beds and loss of spawning gravel.

3. Obstruction of stream channels important to migrating fish with debris.

The Bureau is presently developing guidelines for riparian zone management.

Water

Environmental impacts of mechanical, controlled burning, manual and biological vegetation control methods on water resources are described below.

Mechanical

The possibility will exist for some adverse impacts on water quality because of soil erosion that might occur on a particular project area.

Normally, mechanical methods are used on gentle topography, during dry seasons and buffer strips are left along streams. Increased water runoff (overland flow) may occur during heavy rainstorms.

Controlled Burning

Burning to achieve vegetation control for site preparation does on occasion increase erosion on steep slopes. This is mainly manifested by downstream sedimentation turbidity and also by a nutrient surge in local streams as a result of nitrogen enriched soil being introduced in the water.

Manual

Manual vegetation control methods are expected to have little impact on water quality.

Biological

Livestock on project areas could affect water quality by concentrating in a group on stream banks and in the water thereby causing stream bank erosion leading to sedimentation. In addition, the feces from these animals could introduce biological degradation in the form of undesirable bacteria in important water supplies.

Cumulative Impacts

Cumulative impacts to water quality as a result of non-herbicidal vegetation control methods are not expected to occur.

Conclusions

Potential impacts to the water resource are:

1. Increased water yield from mechanically treated and burned areas.

2. An increase in sedimentation and stream turbidity.

3. A nutrient surge following burning.

4. An increase in undesirable bacteria introduced by livestock.

Visual Resources

Environmental impacts of mechanical, controlled burning, manual and biological vegetation control methods on visual resources are described below.

Mechanical

Areas treated mechanically are usually very obvious right after the treatment. Bare mineral soil is exposed to view in lieu of natural vegetation. The impact can be considered only as negative in relation to desirable visual resource values.

Controlled Burning

Vegetation management with controlled burning produces some sharp visual contrasts in relation to the natural environment. Blackened ground and charred, partially burned down trees and/or cull logs dominate the scene.

Manual

Control of vegetation by manual cutting, hoeing, scalping or digging impacts the visual resource through the removal existing vegetation. However, only target vegetation is removed in contrast to burning or mechanical methods which remove all vegetation. Piles of cut material with brown leaves or in a defoliated state will be on treated areas.

Biological

Biological methods are expected to have little impact on visual resources, however, domestic livestock are not commonly observed in a forested environment.

Cumulative Impacts

Impacts of non-herbicidal vegetation control methods on visual resources are only temporary in nature.

Conclusions

Non-herbicidal vegetation methods will create obvious and dramatic changes in the visual appearance of treated areas. Controlled burning would illustrate the greatest degree of change. Manual methods would be the least obvious to the casual observer.

Human

Environmental impacts of mechanical, controlled burning, manual and biological control of vegetation on humans are described below.

Mechanical

Direct health affects as a result of vegetation control with mechanical methods are related to injuries and deaths to operators that might be incurred from accidents such as machine overturn or malfunctions.

Controlled Burning

There is a risk of controlled burns escaping from control and consuming timber, agricultural crops, residences and other improvements on adjacent lands. Human lives could be also injured or lost.

Manual

Manual control of vegetation can be characterized as very labor intensive and prone to a nigh level of personal injuries because of the hazardous working conditions. An estimated 350 people could be employed full time for a year assuming that the 45,706 acres of conifer release projects identified in the proposal could be done manually. From another perspective, 1,050 people could be employed during the four month period when vegetation control is critical to survival of planted trees.

Projecting extensive use of manual methods into the future it would appear that the acreage requiring treatment and related employment needs would expand expotentially for a period of time as initial treatment areas are re-treated because of the rapid growth of sprouts from cut stems.

Biological

Biological control of undesirable vegetation can affect man if the control agent, be in livestock or insects cannot be confined to the target

area. Agricultural crops, ornamental plant and other nontarget areas can be adversely impacted. Bacteria from livestock can cantaminate water supplies.

Sensitive Areas

Agricultural crops, residences and domestic water supplies could be adversely impacted by the escapement of fire and biological agents. Seasonal employment opportunities will increase if manual methods are used.

Cumulative Impacts

No cumulative impacts have been identified.

Conclusions

1. Non-chemical vegetation control methods present hazard to human health and property resulting from accidents that might occur when working with hazardous tools.

2. Opportunities for employment will increase if manual vegetation management is used.

NO VEGETATION MANAGEMENT

(Alternative C)

The "No Treatment" envisions no vegetation management of any kind for right-of-way maintenance, recreation sites and forest plantations. Environmental impacts of "No Vegetation Management" are described below.

Vegetation

The "No Treatment" alternative will affect vegetation. Grass, tall brush, hardwoods and noxious weeds would increase in road ditches, under powerlines and on road shoulders. Areas from which conifer trees have been harvested would convert to brush fields or grass lands in some areas and to sparsely stocked conifer stands intermingled with brush and weeds. Survival and growth of trees planted after timber removal would be significantly reduced.

Terrestrial Wildlife

Stable habitat conditions, free from man's activities, generally produces predictable species of wildlife. However, slight variations in an area's flora and fauna are constantly taking place through natural changes in habitat.

The "No Treatment" alternative would eliminate increases in browse for deer and elk created by vegetation control. Wildlife escape cover will remain available. Generally, bird populations would remain unchanged for the short term until natural succession progresses towards climax vegetative communities. Cavity nesters, such as the mountain bluebird, white breasted nuthatch, bushy tailed woodrat and others which occupy short snags remaining on cutover lands will be benefitted by the retention of snags. The forest habitat of the dipper, blackcapped chickadee, Wilson's warbler, winter wren and the beaver is improved through retention and or protection of riparian vegetation. In undisturbed areas, animal populations will continue fairly stable at present carrying capacity of the land.

Soil

The "No Treatment" alternative would reduce soil losses from erosion through the rapid invasion of disturbed areas with native vegetation.

Aquatic Organisms

The "No Treatment" alternative would not affect aquatic organisms relative to the existing environment.

Water

The "No Treatment" alternative could improve water quality by allowing the natural vegetation to rapidly invade and expand in timber harvest areas, plantations, road ditches and banks, around buildings and in recreation sites. This vegetation would slow down the rate of water runoff and reduce the amount of sediments and other contaminants carried into main water courses.

Visual Resources

There will be an impact no visual resources as a result of no treatment. The impact will be both positive and negative. Brown foliage resulting from herbicide use will be eliminated impact VRM. In the longrun, brush fields may not look as good as a conifer stand of stately trees. There will be a positive impact on the diversity of landscape.

Human

No vegetation control will result in reducing timber production by 57 to 64 per cent on the individual acres affected. Recent calculations of timber production levels for the Bureau's Josephine Sustained Yield Unit in the Medford District indicates that an average 30 per cent reduction in timber production (28 million board feet) would result if vegetation management was not employed. Reduction in timber harvest affects employment and capital investments in communities that are heavily dependent on federal timber. Impacts of timber harvest on the local and regional economy are expressed in

bureau planning system documents and in the environmental statement on allowable harvest levels now being prepared for the Josephine Unit of the Medford district. Further impacts are described in Chapter III, Future Environment.

Potential health hazards associated with chemical and non-chemical treatment of most competing vegetation would be eliminated. Noxious plants would cause some illnesses to individuals who contacted them.

COMPARISON OF ALTERNATIVES

The factors that are relevant to a decision to use a particular vegetation control method are varied and often unique to the particular situation. Costs, environmental impacts, objectives, effectiveness and timing all play a role in the decision making process.

Figure A illustrates the relative magnitude and duration of the environmental impact (plus or minus) of the alternatives examined.

Figure 9

A Comparison of Residual Environmental Impacts Between the Proposed Action and Three Vegetation Management Alternatives

Environmental Component	Chapter I Proposed Action		"A" No Silvex		"B" No Herbicides		"C" No Control	
	Impact	Length	Impact	Length	Impact	Length	Impact	Length
Vegetation								
Conifers	Mo+	12+	Mo+	12+	Mo+	12+	Ma-	12+
Non-conifer	Mo-	12+	Mo-	12+	Mo-	12+	Mo+	12+
Terrestrial Wildlife								
Habitat	Mo+/-	12+	Mo+/-	12+	Mo+/-	12+	Mo+	12+
Diversity	M-	12+	M-	12+	M-	12+	M+	12+
Numbers	M-	12+	M-	12+	M-	12+	M+	12+
Soil Basic Productivity	N		N		M-	12+	N	
Aquatic Ecosystem								
Vegetation	M-	12+	M-	12+	M	12+	M+	12+
Organisms	M-	U	M-	U	M-	12+	M+	12+
Water								
Quantity	M+	6-12	M+	6-12	M+	6-12	M-	12+
Quality	M-	0-6	M-	0-6	M-	6-12	M+	12+
Visual Resources	M-	12+	M-	12+	M-	12+	M+	12+
Human								
Health	M- U	0-6	M-	0-6	M-	0-6	M+	12+
Sensitive Areas								
(Socio)	M-	0-6	M-	0-6	M-	0-6	M+	12+
Human (economic)	Ma+	12+	Ma+	12+	Ma+	12+	Ma-	12+

Legend

Impact
+ Beneficial
- Adverse

Magnitude
U Unknown
M Minor
Mo Moderate
Ma Major
N None

Length
0 - 6 Less than 6 months
6 - 12 6 to 12 months
12+ More than 12 months

Relative Magnitude (Scale 1 to 10)
Minor = 1-3
Moderate = 3-7
Major = 7 through 10
Unknown = more information is needed to substantiate impacts.

CHAPTER IX

CONSULTATION AND COORDINATION

This draft environmental impact statement was prepared by an interdisciplinary team of Natural Resource Specialists from the Oregon offices of the Bureau of Land Management. Expertise in the fields of forestry, fish biology, hydrology, wildlife biology, soils, visual resources and rare plants were represented on the team.

The preparation of an environmental statement on vegetation management with herbicides is a new experience to the Bureau. However, the U.S. Forest Service with similar vegetation management objectives and methods has issued ES's for each of the National Forests in Region 6 periodically over the last six years. Therefore, Forest Service environmental statement material was used extensively in this statement where appropriate and when available.

The Bureau's Final Environmental Statement, Timber Management, 1975, reflects to a large extent the environmental impacts of the proposed herbicide program. Material in that document was interwoven in this statement.

The Oregon Pesticide use clearing house has been established to assist in the review of herbicide use proposals. The signatory members to the memorandum of understanding will review all proposals.

PROFESSIONAL CONSULTATIONS

Individual team members contacted on an informal basis individuals with special expertise in the following organizations:

U.S. Environmental Protection Agency

Oregon State University

Pacific Northwest Forest & Range Experiment Station

U.S. Forest Service, Region 6

U.S. Fish and Wildlife Service

REQUESTS FOR INPUT TO DES

A request for input to the proposed environmental statement and a tentative outline for the statement was mailed to Federal agencies, State agencies, resource groups and individuals. A condensation of this list follows:

Federal Agencies

Bonneville Power Administration

Bureau of Indian Affairs

Bureau of Outdoor Recreation

Environmental Protection Agency

Federal Energy Administration

Fish and Wildlife Service

Geological Survey

National Park Service

Pacific Northwest Forest and Range Experiment Station

Regional Solicitor, U.S. Department of Interior

U.S. Department of Transportation, Federal Highway Administration

U.S. Forest Service, Region 6

State Agencies

Department of Economic Development

Department of Environmental Quality

Department of Fish and Wildlife

Department of Forestry

Department of Transportation

Parks and Recreation Branch

Soil Conservation Service

Soil and Water Conservation Department

Wildlife Commission

Interest Groups

American Forest Institute

Associated Oregon Loggers, Inc.

Association of O&C Counties

Audubon Society of Portland

Cascade Holistic Economic Advisors

Citizens for a Clean Environment

CLEAN AND BEAUTIFUL INCORPORATED

Committee of Women on the Environment

Council of Governments (Lane, Rogue, Mid-Williamette)

Crown Zellerbach Corporation

Dean Sherman, Inc.

Defenders of Wildlife

Federal Information Center

Friends of the Earth

Friends of Oregon

Industrial Forestry Association

Izaak Walton League of America

Keep Oregon Green Association

National Wildlife Association

The Nature Conservancy

Northwest Timber Association

Oregon Historical Society

THE ORV MONITOR

OSPRIG

Pacific Logging Congress

Public Lands Council

Sierra Club

Society of American Foresters

SOLV

Western Forestry and Conservation Association

Western Forestry Industry Association

Western Wood Products Association

Wilderness Society

Wildlife Management Institute

Wildlife Society

Responses to the request for input to the preparation of the environmental statement were received from:

1. Bonneville Power Administration
2. Oregon Water Resources Department
3. Oregon State University, Professor Mike Newton
4. International Paper Company
5. Washington State Department of Natural Resources
6. Oregon State Historic Preservation Office

Suggestions made by these organizations were considered in preparing the draft environmental statement.

A list of the agencies, organizations and individuals to whom the draft statement will be sent for comment is contained as an attachment to the summary of this environmental statement.

Public hearings will not be held.

GLOSSARY

Absorption - The incorporation of one substance within another.

Acute toxicity - Adjustment of an organism to changes in its environment.

Adjuvant - Substances which are added to spray materials to act as wetting or spreading agents, stickers, penetrants, emulsifiers, etc. aiding in the physical characteristics of the herbicide materials.

A.E. - Acid Equivalent. The amount of active ingredient expressed in terms of the parent acid.

Aerial spray - Broadcast aerial application of a herbicide as a solution emulsion, or wettable powder as a spray applied from helicopters or fixed-wing aircraft.

Anadromous fish - Fish spending most of their lives in the sea, but ascending freshwater rivers to spawn.

Basal spray - Application of a coarse-droplet spray at low pressure on the basal portion of stems to a height of 12 to 18 inches above the soil surface. Spray is applied until an excess runs off onto the soil surface at the base of the stem.

Biodegradable - Able to decompose readly by the action of micro-organisms.

Broadleaf plants - Usually refers to herbaceous plants with broad, flat leaves as opposed to grasslike plants with very narrow leaves.

Brush control - Control of woody plants.

Buffer strip - A zone left untreated; usually at the outer margin of the treated area or adjacent to streams.

Carcinogen (carcinogenicity) - Any substance that produces cancer (the ability to produce cancer).

Carrier - A liquid or solid material added to an herbicidal chemical or allow easier mixing, storage, shipment, and application in the field. In this publication, the term refers especially to oil, water, or both added to the commercial formulation to increase its volume and allow application of small amounts of active ingredient over a large area.

Chronic Toxicity - The poisoning effects of a series of small doses applied over a long period.

Cumulative - Brought about or increased in strength by successive additions.

Dormant spray - Application of chemical in winter or very early spring before treated plants show any evidence of active growth.

Drift - The movement of air-borne particles from the intended contact area to other areas.

Exotic Vegetation - Plants not native to a given area.

Food chain - The transfer of food energy from producers through a series of consumers, usually four or five.

Full Stocking Level Control - Intensive management, carrying at least recommended stocking of coniferous trees per acre at a given age and diameter.

Growth regulator - A chemical or herbicide, which, when applied in small amounts to leaves, stems, or roots, alters the normal growth and form of the plant. Phenoxy herbicides are classified as growth regulators.

Herbicide - A phytotoxic chemical used for killing or inhibiting (stunting) the normal development of a plant.

Label - All written, printed, or graphic matter on or attached to the herbicide container as required by law.

LC_{50} - A lethal concentration rate at which 50 percent of the test animals will be killed. Usually expressed in ppm (see below) and usually used in testing of fish or other water animals.

LD_{50} - A lethal dosage rate at wich 50 percent of the test animals will be killed. Usually expressed in terms of milligrams of chemical per kilogram of body weight of the test animal (mg/kg).

Leach - Usually refers to the movement of chemicals through a soil by or with an amount of water that is in excess of the soil's moisture-holding capacity. May also refer to movement of herbicide out of leaves, stems, or roots into the air or soil.

Mean annual flood - that flood which could be expected to be equaled once every two years.

Meiosis - The complex nuclear charges resulting in cells with half the number of chromosomes present in the original cell.

mg/kg - Milligrams of chemical per kilogram of body weight of test animal (also see LD_{50}).

microorganisms - A living organism so small that it can be seen only with a microscope.

Mutagen (mutagenicity) - A mutation inducing agent. An agent that tends to increase the occurrence or extent of mutation.

Nonselective herbicide - Formulations of herbicides that destroy or prevent plant life in general without regard to species. Soil sterilants are classified as nonselective herbicides, although one or more species on an area may not be controlled even by such herbicides.

Nontarget Component or Vegetation - Vegetation which is not expected or not planned to be affected by the treatment.

Noxious weed - A weed arbitrarily defined by law as being especially undesirable, troublesome, or difficult to control.

Oral toxicity - Toxicity - Toxicity of a compound when it is ingested.

Perennial - A plant that lives for many years. The tops may die back in winter or in severe drought, but the rots or rhizomes persist.

Pesticide - Any substance or mixture of substances intended for controlling insects, rodents, fungi, weeds, and other forms of plants or animal life that are considered to be pests.

Phenoxy herbicides - Formulations of 2,4-D; 2,4,5-T; and 2,4,5-TP.

Physiographic Province - A mapped description of the features and phenomena of nature, including landform, soils, vegetation, and climate.

Phytotoxic - Poisonous or injurious to plants.

ppb - parts per billion, e.g. 1 ppb might refer to one gallon of herbicide in one billion gallons of water.

ppm - parts per million.

ppmw - Parts per million by weight.

ppt - parts per trillion.

Rate or Dosage - These terms are synonymous. "Rate" is the preferred term. Rate usually refers to the amount of active ingredient of a herbicide (such as 2,4-D acid equivalent) applied to a unit (such as 1 acre) regardless of percentage of chemical in the carrier.

Registered - Pesticides that have been approved for use by the Environmental Protection Agency.

Riparian vegetation - that vegetation growing on the bank of a stream or other body of water, such as pond, lake, marshes, and reservoirs.

Seral stage - The relatively transitory communities within a sere.

Sere - The whole series of communities which develop in a given situation.

Selective herbicide - One which is more toxic to some species of plants than others. Thus, weeds may often be controlled without significant damage to trees or other plants by selective herbicidal action.

Spot Spraying or Treatment - An application of a pesticide to localized or restricted areas (generally a few square feet) as differentiated from a broadcast application (generally covering many acres).

Stream bank - The slope immediately bordering a stream course along which the water normally runs during a mean annual flood.

Stream classes - Four classes are defined using the present and foreseeable uses made of the water, and the potential effects of on-site changes on downstream uses. Importance of use will be relative to the general area; consequently, size is not necessarily a criterion for classification. Whole streams or parts of stream can be classified; in short, one stream may be sectionalized into several classes.

Class I - Perennial or intermittent streams or segments thereof that have one or more of the following characteristics: (1) Direct source of water for domestic use, i.e., cities, recreation sites, etc. (2) Used by large numbers of fish for spawning, rearing or migration. (3) Flow enough water to have a major influence on water quality of a Class I stream.

Class II - Perennial or intermittent streams or segements thereof that have one or both of the following characteristics: (1) Used by moderate though significant numbers of fish for spawning, rearing, or migration. (2) Flow enough water to have only a moderate and not clearly identifiable influence on downstream quality of a Class I stream, or have a major influence on a class I stream.

Class III - All other perennial streams or segments thereof not meeting higher class criteria.

Class IV - All other intermittent streams or segments thereof not meeting higher class criteria.

Sublethal - Involving a stimulus below the level that causes death.

Target Component or Vegetation - Vegetation which is expected or planned to be affected by the treatment.

Tolerance - (pesticide) - The amount of pesticidal chemical allowed by law to be in or on plant or animal products sold for consumption (see also "Residue tolerance.")

Tolerant - Capable of withstanding the effects of herbicides. For example, grass is tolerant of 2,4-D to an extent that allows this herbicide to be used selectively to control broad-leaved weeds without killing the grass.

Toxicity - Degree to which something is poisonous or physiologically injurious.

Turbidity - Cloudiness of the water.

Vegetational Succession - The order in which plants become established and grow in nature. Usually after a fire or other disturbance, simple annual plants become established first, then successively more complex and long lived plants.

Volatile - A compound is said to be volatile when it vaporizes at ordinary temperatures on exposure to air.

Warm and cold-water fish - Groups of fish distinguished by the adaptation of the eggs to development in warm or cold water.

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APPENDIX A

DEPARTMENT OF INTERIOR POLICY

AND GUIDELINES

ON

THE USE OF HERBICIDES

Department of the Interior Responsibilities

and Policy on Pesticides and Guidelines for Use

Responsibility and Policy

The Department of the Interior has the responsibility of assuring maximum protection to the environment.

The Department will use all means to reduce pollution resulting from pesticide use.

It will be the policy of the Department to consider safety and environmental quality as the primary factors in making a decision on whether or not to use a pesticide.

In areas and programs under its jurisdiction, it will be the policy of the Department to:

1. Conform with all provisions of Federal and State pesticide law and Executive Order 11643.

2. Not to use chemicals named on the USDI Prohibited List.

3. Use chemicals on USDI Restricted List only when:

a. Non-chemical techniques have been considered and found inadequate, and

b. Use can be limited to small scale application.

4. Use of any chemical pesticide must be aimed at a specific pest problem and involve minimum strength and frequency of application.

Department of the Interior Guidelines for Use of Pesticides:

1. Chemical pesticides should not be used alone when non-chemical or integrated chemical and non-chemical techniques offer an alternative.

2. No pesticide will be used when there is basis for belief that:

a. Water quality will be degraded, and

b. Hazards exist that will unnecessarily threaten fish, wildlife, their food chain, or other components of the natural environment

3. Large scale nonspecific applications will not be made of any pesticide.

4. A contingency plan will be developed for all pesticide storage areas to:

a. Prevent pesticide spills from affecting areas outside of the storage areas.

b. Take remedial action if the spill extends out from the storage area, and

c. Formulate disposal methods.

5. Federal, State, and local authorities will be kept informed concerning pesticide research and control programs of interest to them and their views will be solicited and considered when formulating our own programs.

6. All applications of pesticides will conform to the guidelines and standards of the President's Cabinet Committee on the Environment - Subcommittee on Pesticides.

7. To assure compliance with Departmental policy and to facilitate review of Interior's pesticide programs, and "Intradepartmental Pesticide Working Group" was formed. The Working Group is made up of representatives from each agency. Each agency representative is responsible for coordination and necessary review of the agency's program before it is sent to the Working Group of the Pesticide Subcommittee of the Cabinet Committee.

USDI Prohibited List

aldrin
amitrole
arsenical compounds (inorganic)
Azodrin
Bidrin
DDT
DDD (TDE)
2,4,5-T
dieldrin
endrin
Heptachlor
lindane
mercurial compounds
Strobane
thallium sulfate
toxaphene

USDI Restricted List

acrolein
aldicarb (Temik)
Aramite
arsenical compounds (organic)
azinphosmethyl (Guthion)
  and homologs
Benomyl
BHC (benzene hexachloride)
captan
carbaryl (Sevin)
carbophenothion (Trithion)
  and homologs
chlordane
chlorobenzilate
coumaphos
cyanide compounds
demeton (Systex)
dicamba (Banvel D)
dinitro-cresols
dioxathion (Delnav)
diquat
disulfoton (Di-syston)
Dursban
Dyfonate
endosulfan (Thiodan)
endothall
EPN
ethion (Nialate)
fenac
fenthion (Baytex)
folpet (Phaltan)
Furadan
Imidan (Prolate) (phosmet)
Kepone (outdoor uses)
Matacil
Meta-Systox
methyl bromide
mevinphos (Phosdrin)
Mirex
paraquat
parathion and homologs
PCNB (pentachloronitrobenzene)
phorate (Thimet)
phosphamidon
picloram (Tordon)
sodium monofluoroacetate (1080)
TCMTB (Busan 72)
TEPP (Tetron)
trichlorofon (Dylex, Dipterex)
Zectran

APPENDIX B

WATER MONITORING PROCEDURES

SAMPLING OF STREAMS FOR HERBICIDE RESIDUE

Treatment area layout.--The degree of stream contamination is greatly influenced by the orientation of the treatment unit so consider the need for monitoring when laying it out. If at all possible, spray boundaries should be laid out so that live streams are not included.

Avoiding larger streams during spray application is usually not difficult, but it may be impractical to avoid all of the small streams in an area that requires brush control. Municipal watersheds and water sources for fish hatcheries and private landowners require special attention.

Sampling points.--Selection of an appropriate sampling station is extremely important since the value of the information obtained is only as good as the sample collected. The sample should be representative of the volume of water passing the sampling point, and the samples should be collected avoiding stirring up bottom sediments or kicking surface debris into the stream. When the treatment unit lies adjacent to the stream to be sampled, the sampling point must be downstream of all small side channels flowing from the treated area. At the same time, however, we want to sample the stream as close to the lower boundary as possible so that the samples will represent the maximum concentration of chemical to which aquatic organisms may have been exposed.

Control samples are collected at the sample sampling station pior to spraying in main stream just below confluence of all affected tributaries.

The sampling point should not be subject to contaminaton by aerial drift during the sampling period. In critical situations such as spraying brush above a water intake for a fish hatchery or private water supply, sampling stations should be established near the in intake.

Collection of samples.--Before the project is begun, appropriate sample containers must be obtained. The type and size of sample, the container and conditions for storage and transport should be verified with the analytical laboratory. Herbicide samples should be taken in sterilized glass containers.

As indicated earlier, the sample should be as representative as possible of the total volume of water flowing past the collection point. Obtain an integrated sample, using a point sampler such as a DH48 sampler, obtaining an integrated sample of the stream flow. The integrated sample must transverse both the width and depth of the stream. Experienced personnel familiar with this procedure should be used.

The individual collecting the samples <u>must not</u> have any herbicides or other contaminants on his hands or clothing and the sample containers must also be free of contamination. These precautions are extremely critical because of the sensitivity of analytical methods.

Each sample must be clearly identified and all pertinent information correctly and completely recorded on a tag or label securely attached to the container. In addition to assigning an identifying number, the attched tag or

label should show the date and time collected, location, weather conditions since time of aplication, and name of collector. Other information that may be recorded is the rate of application, chemical formulation used, and size of area treated.

Sampling Periods:

1. Previous to spraying for control purposes (water will be analyzed for all common herbicides including 2,4,5-T, Amitrole-T).

2. Immediately after spraying.

3. One day after spraying.

4. First two storm events.

5. Leaf fall.

6. Following year.

Timing of the collection of sample number 2 depends on the distance between the lower unit boundary and the sampling point. If this point is immediately below the unit, sample 2 should be taken as described. If the sampling point is downstream some distance below the unit, collection of sample 2 must be delayed to correlate with the flow duration from the time of spraying.

Samples 5 and 6 may not be taken if prior sample(s) indicate no contamination.

Due to poor weather, equipment failure, or the size of the area, it is often necessary to spray a unit over a period of several days. Should this occur during a monitoring program, samples should be taken to comply with each time that spray is applied.

When the treatment unit lies within a municipal watershed or in a watershed that supplies a fish hatchery, additional samples should be taken to comply with those users regulations. These samples would be taken downstream just above any critical installation, such as a fish hatchery or domestic or crop use.

Transport and storage.--Sample containers, whether empty or full, should not be transported or stored with chemicals. The chance of sample contamination can also be greatly reduced by assigning an experienced person who is not involved in any part of the spraying operation to sample collection and handling. As soon as sampling has been completed, the accumulated samples should be shipped to the laboratory for chemical analysis. If for some reason the samples are not analyzed immediately, storage conditions should be verified with the analytical laboratory.

SAMPLING OF PONDS, LAKES AND MARSHES FOR HERBICIDE RESIDUE

The time and procedures of sampling are much the same as that of streams.

The water samples should be representative of the water body, and the samples should be collected avoiding stirring up bottom sediments or kicking surface debris into the water. The herbicide samples should be taken in glass containers. Obtain an integrated sample, using a point sampler transversing the depth of water. Experienced personnel familiar with this procedure should be used.

The sampling periods should be the same as that of streams, except sample period 2 "Immediately after spraying" need not be adjusted because of sampling point location.

SAMPLING OF GROUND WATER FOR HERBICDE RESIDUE

Sampling of ground water rarely need be sampled except in cases of a very high water table of 10 feet or less.

If sampling is found necessary, a well or wells should be pumped until formation water is being yielded and take the sample(s) in sterilized glass containers.

Herbicides have little chance of reaching ground-water aquifers because of rapid degradation and resistance to leaching. Amongst the most mobile of the herbicides is 2,4-D with a leaching rate through soil at 6 to 8 inches with a rainfall of 50 inches. Only water tables a few feet or less below the land surface would have detectable effects on ground water in storage and almost no chance of being present in detectable amounts in water when discharged by wells, springs and into streams. Excessive concentrations of persistent herbicides may be present in areas of high water tables such as marshes.

CHEMICAL ANALYSIS

Chemical analysis for pesticide residues is an expensive proposition because of the time and equipment required. It may be desirable, therefore, to reduce the cost of monitoring on less projects by compositing some of the samples and thereby reducing the number of analyses required. This can be done by combining equal parts of each of several samples taken at a monitoring point, excluding the control sample. No more than 4 or 5 samples should be included in a composite and the remainder of each individual sample should be saved in case the analytical results on the composite show that more detailed information is needed. The composite sample must be so marked and a complete identification included with it when submitted for analysis (Norris, Moore, Thut, Freed, Lauterbach, 1971).

WATER ANALYSIS CONTACTS

1. Bacterial Water Contamination

   Testing for water quality

   Public Health Lab.
   Oregon State Health Div.
   1400 S.W. 5th Ave.
   Portland, Oregon 97201

2. Identifying sources of contamination

   Oregon State Health Division
   Community Environmental Health
   1400 S.W. 5th Ave.
   Portland, Oregon 97201

   This organization can perform tests to determine if sewage effluent is reaching streams.

3. "Water Measurement Manual"

   Bureau of Reclamation
   Denver, Colorado
   1953 1271 pp.
   Denver Federal Center
   Denver, Colorado 80225

4. Analysis of Samples for Pesticide Residue

   (See att. No. 1)

   Sampling jugs cost $1.02 each
   Cost per analysis $55.87

   State Department of Agriculture
   Agriculture Building
   Salem, Oregon 97310

5. Linn-Benton Community College
6500 S.W. Pacific Boulevard
Albany, Oregon 97321

(Can provide training in water quality testing, etc.)

James D. Fulton - Wastewater technology
John F. Wooley
Ph. 928-2361

6. MEI - Charlton Inc.
2340 S.W. Canyon Road
Portland, Oregon 97201
Ph. 228-9663 (See att. No. 2)

7. Loren Kramer, Director
State of Oregon
Department of Environmental Quality
1234 S.W. Morrison Street
Portland, Oregon 97205

Water Quality Control
Fred Bromfield 229-5749
Glenn Carter 229-5696

8. Regional Administrator, Region X
U.S. Environmental Protection Agency
1200 Sixth Avenue
Seattle, Washington 98101

Robert S. Burd - Director, Water Division
Bill Clothier - Non point Pollution Section 442-1086
Albert Moore - Staff
Dick Brow

John Vlastelicia, Director, Oregon Operations Office
1234 S.W. Morrison
Portland, Oregon 221-3250

EPA Pesticide Div. Oregon Office
511 N.W. Broadway
Portland, Oregon 221-2820

9. Misc. list of Pesticide Analytical Services. See att. No. 3.

10. USGS Central Lab.
1750 S. Redwood Rd.
Salt Lake, Utah

11. USGS Central Lab.
6481 Peach Tree Industrial Bld.
Doraville, Georgia

12. USGS Central Lab.
Denver Fed. Center, Bld. #15
Lakewood, Colorado

13. Umpqua Research Co.
P.O. Box 791
Myrtle Creek, Oregon

14. Most colleges and universities as:

(1) OSU Lab. at Corvallis, Oregon
(2) Portland State University
(3) Eastern Washington State College

15. Okanogan County Health Dept.
Box 646
Okanogan, Washington 98840

16. Chemical Analysis

Water Analys
304 Blair Blvd.
Eugene, Oregon 97402

Oregon Certified Laboratory No. 72
Inv. No. 2279 - Purchase Order #36100-PH5-48

17. Northwest Testing Laboratories, Inc.
4115 N. Mississippi Ave.
Portland, Oregon 97217

18. Hibbs Laboratories
2808 Cassia Street
Boise, Idaho 83705

APPENDIX C

DRAFT EPA DIOXIN: POSITION DOCUMENT

MAY 11 REC'D

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

4 MAY 1977

SUBJECT: Dioxin: Position Document

TO: Dioxin Implementation Task Force

FROM: Edwin L. Johnson
Deputy Assistant Administrator
for Pesticide Programs

When we met last fall I agreed that the Agency would put together a summary of what it had learned since withdrawal of the hearings in 1974. You have been cooperating with EPA in the conduct of a monitoring program to determine the extent and frequency of dioxin (TCDD) residues in the environment as a result of the use of 2,4,5,-T and related pesticides. The attached document is a draft of our evaluation of phase I of the Dioxin Implementation Plan and a summary of our plan for proceeding with phase II of the program. As I indicated to you last fall, this document is being provided to you in advance of a formal release for comment and suggestions. It has also been made available to the Administrators Pesticide Policy Advisory Committee for the same purpose.

We intend to make the document final and release it generally in the latter part of May and we therefore would appreciate you submitting any comments or suggestions you have for modifying this document by May 19, 1977. All correspondence should be forwarded to Mr. W. Thomas Hollaway WH-566, Office of Special Pesticide Reviews, Environmental Protection Agency 401 M Steet S.W. Washington, D.C. 20460 (Telephone No. 202/755-9336). Your cooperation in this program in the past and your suggestions for this document as well as the future directions of the program will be greatly appreciated.

Ed Johnson

Attachment:

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SEP
STATE & PRIVATE
FORESTRY

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Dioxin: Position Document

Page

I. Background.....2
A. Chemical and Physical Properties of TCDD...2
1. Synthesis.....2
2. Environmental Characteristics.....2
B. 2,4,5-T Litigation History.....3

II. Dioxin Implementation Plan.....7
A. Introduction.....7
B. Analytical.....8
1. Phase I Beef Fat and Liver.....8
2. Survey of Trichlorophenol Pesticides for TCDD Residues..... 8
C. Toxicological Effect Level.....9

III. Future Analytical Studies 9

IV. Summary.....11

V. Appendix.....12

A. Interpretation of Phase I Data by Analytical Collaborators.....12
B. Phase II Experimental Design.....13

DRAFT 26 APR

I. Background

A. Chemical and Physical Properties of TCDD

1. Synthesis

TCDD is not found naturally in the environment, its source comes as a by-product in the manufacturing process of several chemical products.

Although there are several synthetic routes for the formation of TCDD, the more common reaction occurs under conditions which are used to prepare 2,4,5-trichlorophenol, tetrachlorobenzene being the precursor compound. Under extreme saponification reactions, 2,4,5-trichlorophenol is formed. This reaction was first established by Schwetz, et al. (1). This means that TCDD or other chlorodibenzo-p-dioxins will always be present in trichlorophenol products and/or their derivatives, and that any use of these products will result in environmental contamination by dioxins.

2. Environmental Characteristics

Basically there are three ways in which TCDD may be introduced into the environment: (1) it may be present as a contaminant in chlorophenols or their derivatives, (2) it may be formed from chlorophenols or their monomeric chlorophenoxy derivatives under conditions of use or storage, or (3) it may be formed from phenoxyphenols or other polymeric derivatives under similar conditions. In those cases where TCDD residues have been found in environmental samples, it is not known at present which of these routes is responsible. Kearney's, et al. (2) study of the fate of TCDD in the environment, however, has resulted in the following observations:

1). TCDD does not leach vertically in soils;

2). Significant amounts of TCDD are not taken up by plants and none could be harvested in grain or soybeans;

3). TCDD disappears slowly from soils and about half is lost after one year. It is less persistent than most chlorinated hydrocarbon insecticides, but more persistent than 2,4,5-T;

4). TCDD is not translocated from the point of application on the leaf surface to other parts of the plant. Some of it is washed off with rain water;

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5). TCDD destruction may be caused by sunlight in water, but not on soil surfaces;

6). TCDD is not made from breakdown products of 2,4,5-T in soils or in sunlight;

7). Although there are some residues in the liver, large amounts of TCDD fed in an animal's diet can be eliminated in the urine and feces;

8). TCDD was accumulated from water by fish in laboratory studies.

Further information on the persistence and mobility of TCDD in the environment will be available in late 1977 as a result of an interagency research agreement between EPA and USDA. The research being conducted at the USDA-ARS Degradation Laboratory is designed to provide data on the fate of TCDD when Silvex is applied in simulated home and recreational turf plots. Dr. Kearney is the Laboratory leader for the investigation.

Since TCDD is likely to be formed in the preparation of 2,4,5-trichlorophenol and since this compound is common to the manufacturing process of the pesticides 2,4,5-T, Silvex, Erbon, Ronnel and 2,4,5-trichlorophenol, all four compounds were included in the dioxin monitoring program as possible sources of TCDD contamination.

B. 2,4,5-T Litigation History

On October 29, 1969, the President's Science Advisor announced that a series of coordinated actions was being taken by several governmental agencies to restrict the use of the herbicide 2,4,5-trichlorophenoxyacetic acid (2,4,5-T). This was precipitated by the release of a screening study conducted by the Bionetics Research Laboratories in which it was found that mice and rats treated during early pregnancy with large doses of 2,4,5-T gave birth to defective offspring.

The announcement, together with reports of an increased occurrence of birth defects by South Vietnamese newspapers (June and July 1969), elicited immediate reactions from governmental agencies, segments of the scientific community, various lay groups concerned with environmental problems, and from public communications media. Government-sponsored panels of experts, special commissions set up by scientific organizations, hearings before subcommittees of the U.S. Senate, and conferences attended by representatives from industry, government, and academia examined available data and heard expert opinions. None of these groups, however, were able to conclusively resolve the central question of whether 2,4,5-T, constituted a risk for human fetuses during pregnancy as currently produced and used. At least one reason for failure to reach a satisfactory resolution of the issue was the paucity of reliable, scientific evidence.

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Additional animal experiments performed early in 1970 confirmed that the purest available sample of 2,4,5-T given in large doses to pregnant mice, did indeed result in the birth of malformed offspring (3,4). It was later reported (5,6) that the 2,4,5-T formulation employed in these studies contained 30ug/g of 2,3,7,8-tetrachloro-dibenzo-p-dioxin (TCDD), one of the most toxic and potent teratogenic substances known (1,7). On April 14, 1970, precautionary actions were taken by the Secretary of Health Education and Welfare, who advised the Secretary of Agriculture that: "In spite of the uncertainties of the experimental data related to 2,4,5-T, the Surgeon General feels that a prudent course of action must be based on the decision that exposure to this herbicide may present an imminent hazard to women of child bearing age." Accordingly, on the following day the Secetaries of Agriculture, of Health, Education, and Welfare and of the Interior jointly announced the suspension of the registrations of 2,4,5-T for: "I. In all uses in lakes, ponds or on ditch banks. II. Liquid formulations for use around the home, recreation areas and similar sites" (USDA-PRD PR 70-1, 20 April, 1970). A notice for cancellation of registration was issued on May 1, 1970 for: "I. All granular 2,4,5-T formulations for use around the home, recreation areas and similar sites. II. All 2,4,5-T uses on crops intended for human consumption." (USDA-PRD PR 70-13, May 1, 1970) All registrants were advised of these actions, and two of the registrants, Dow Chemical and Hercules Incorporated, exercised their right under Section 4.e of the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) [7 U.S.C. 135 et seq.] to petition for referral of the matter (for the cancellation of rice only) to an Advisory Committee.

As provided by that statute (8), the National Academy of Sciences supplied a list from which was selected a nine-member Advisory Committee of scientists with appropriate qualifications from universities and research institutes throughout the county. The charge given to the Committee was to: (a) consider all relevant facts, (b) submit a report and recommendations regarding registration for certain uses of 2,4,5-T, and (c) state the reasons or bases for these recommendations. The Report from the Committee was submitted to the Administrator of the Environmental Protection Agency on May 7, 1971 (9). The report recommended that 2,4,5-T may be permitted under certain conditions for uses in forestry, range and rights-of-way providing:

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1. That the limit of 0.1 ppm of contamination with TCDD be set for all future production of 2,4,5-T.

2. That 2,4,5-T be applied no more than once a year at any one site.

3. That 2,4,5-T be applied with proper caution so that it will not contaminate other areas where it may come into human contact. The Committee also recommended that this action be reviewed again when the existing deficiencies in information relative to possible magnification in the food chain of TCDD have been rectified by specific research directed toward that end.

In July 1972, Dow Chemical obtained an injunction against EPA enjoining further administrative action against 2,4,5-T. In 1973, the United States Court of Appeals for the Eighth Circuit overturned the injunction and administrative proceedings were allowed to go forward (10). Accordingly, a notice of intent to hold Public Hearings on all uses of 2,4,5-T brush-weed killer was filed with the EPA Hearing Clerk on July 20, 1973, under Section 6(b)(2) of FIFRA. All federally-approved uses of the controversial brush-and-weed killer, 2,4,5-T, alleged to have caused adverse effects on human and animal health, were to be explored in a public hearing scheduled for April 1974, following completion of an intensive monitoring program for detecting dioxin in the parts per trillion (ppt) range (38 FR 19869, July 24, 1973). The hearing was to afford ~~to~~ all concerned parties--manufacturers and formulators, the U.S. Department of Agriculture (USDA), the Environmental Defense Fund (EDF), and other interested groups as well as the EPA--the opportunity to present pertinent scientific, economic, and other relevant data needed by EPA to weigh the benefits of the herbicide against the risks involved.

The basic question to be resolved by EPA through the hearing process was whether the remaining Federal registrations of 2,4,5-T should be cancelled or the classification changed.

During the preparation of the hearings, it was evident that the pesticide 2,4,5-T, per-se, posed no special cause for concern, when used as directed.*

* Note: 2,4,5-T, 2,4,5-TCP, Silvex, Erbon, and Ronnel are now under review in the Office of Special Pesticide Reviews (OSPR), EPA, as candidates for Rebuttable Presumption Against Reregistration (RPAR). The toxicity of these pesticides and/or the associated dioxin contaminant are considered in this review process.

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Residue monitoring analyses for 2,4,5-T in environmental samples, including food, have for the most part led to negative findings. In those cases where positive results were obtained, levels were low (normally less than 0.1 ppm). This conclusion was based primarily on the results of an EPA forced feeding study of the levels of 2,4,5-T in cows milk and calf tissue, following exposure. These observations, coupled to the low order of teratogenicity for 2,4,5-T when tested at the highest purity available, lead to the conclusion that human exposure to 2,4,5-T from normal usage posed no discernible problem.

On May 10, 1974, the information hearing was expanded to include all insecticides and herbicides having in their manufacturing process 2,4,5-trichlorophenol (TCP). These include the pesticides Silvex, Erbon, Ronnel and 2,4,5-TCP all of which have the potential of containing TCDD.

On July 24, 1974, the Agency withdrew cancellation and information gathering proceedings initiated against the herbicide 2,4,5-T and related compounds. The proceeding was withdrawn because of the inability of the Agency to monitor food for residues of 2,4,5-T's highly toxic contaminant TCDD with the necessary analytical precision. The lack of evidence that 2,4,5-T use results in exposure of man to TCDD made a final determination on the "unreasonable adverse effects" caused by the use of 2,4,5-T extremely difficult, if not impossible. Accordingly, while the 2,4,5-T notice of hearing was withdrawn, the Agency stated that it:

> "will continue its TCDD residue monitoring program and will take such further action as it deems appropriate once the results of the monitoring project are available." 39 FR 24050 June 28, 1974.

On July 25-26, 1974 the Agency held a Dioxin Planning Conference in Washington, D.C. The public meeting was held primarily for those parties having an interest in the withdrawn 2,4,5-T/dioxin hearings. The nature of the meeting was to address data analysis and retreival (in the areas of analytical methodology, toxicology and monitoring) with emphasis on analytical methodology for TCDD at the parts per trillion level (ppt). As a result, the Agency promulgated the Dioxin Implementation Plan which is designed to develop the required analytical methods for the determination of dioxin residues in environmental samples.

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II. Dioxin Implementation Plan

A. Introduction

In September 1974, the Agency sent out a Preliminary Dioxin Implementation Plan (DIP) to all attendees of the Planning Conference requesting that it be reviewed and that they provide input on what changes or additions would be advisable in the overall plan. After these responses were received, a final plan was prepared in February 1975. It consists of two parts, a short term monitoring program and a broad research plan which would take four to five years to complete. The EDF, USDA and Dow Chemical agreed to participate in a monitoring program established by EPA, which would utilize improved analytical methodology capable of TCDD detection at the ppt level.

The short term beef fat monitoring plan was a joint plan (representatives from EPA, USDA, EDF and Dow Chemical) in which beef fat and liver samples were to be collected at six month intervals to permit timely reevaluation of any available evidence for TCDD residues. Such reevaluation could lead to (1) modifications in plans for future research and monitoring and/or (2) reconsideration of the desirability of initiating some form of regulatory action on 2,4,5-T or other pesticides contaminated by TCDD. At each point all of the information then available should be considered even though the specific experiment producing it might not be completed. The guiding principles for the sampling plan were:

a. The samples should be representative of beef actually being consumed by some segment of the population.

b. The sample should represent cattle likely to be marketed for human consumption and grazed on lands treated with 2,4,5-T and thus likely to maximize the probability of containing 2,4,5-T (or TCDD).

Between February and March, 1975, the first 85 beef fat and 43 liver samples were collected. At the outset it was decided that emphasis would be placed on analytical methodology. Due to the complexity of the analytical technique to determine TCDD at the ppt level, analysis for these first 128 samples were delayed and not completed until May 1976. Approximately twenty-five percent of these samples was taken from non-treated areas, i.e., where 2,4,5-T or TCDD is not likely to be found. One laboratory prepared all sample extracts, and identical aliquots were sent to all participating analytical laboratories. The purpose of having one laboratory perform all cleanup of samples was to minimize possible8errors in the procedure.

DRAFT 28 APR 1977

B. Analytical

1. Phase I Beef Fat and Beef Liver Anaylyses

The primary analytical achievements of 1976 have been the; 1) completion of phase I beef fat and liver analyses using combined gas chromatographic (GC) and using high resolution, mass spectrometric (MS) techniques; 2) analysis of technical grade pesticides for TCDD residues; 3) further refinement of cleanup methodology for environmental samples; and 4) the development of a preliminary method for the extraction analysis of human tissues and milk for TCDD residues.

The progress made in the area of TCDD analytical methodology is noteworthy. By far the most significant data out of the above is the phase I beef and liver analyses. Based on the repeated ability of more than 1 laboratory to detect TCDD in identical sample aliquots, it is clear that dioxin can be detected at the ppt level. The data as reported by the collaborators at the June 15, 1976 meeting in Washington (see section V Appendix part A) are suggestive of TCDD residues in beef fat ranging from 20-60 ppt.

Phase I of the program was primarily intended to identify acceptable methods for extraction and analysis of TCDD in environmental samples. This phase of the program is essentially complete. A short term study (90 days) will be conducted, prior to initiation of phase II, to determine the optimal combination of extraction and analytical methods. Once this combination has been determined, the Agency will immediately proceed with the second phase of the program. Phase II will proceed under an experimental design intended to insure the accuracy and legal sufficiency of the analytical data being developed (see section III Future Analytical Studies).

2. Survey of Trichlorophenol Pesticides for TCDD Residues.

Samples of trichlorophenol materials were received from the basic manufacturers of pesticides for analysis of TCDD content by EPA. The limit of detection in the analysis was 0.1 ppm, corresponding to the 0.1 ppm limit for TCDD contamination of 2,4,5-T, as set by the 2,4,5-T Advisory Committee (NAS) in 1970. Seventy-three out of the 75 samples collected did not contain TCDD at the above limit of detection. The remaining 2 samples, ronnel and Na-2,4,5-T phenate are believed to contain 0.107 and 0.312 ppm of TCDD respectively. These samples will be reanalyzed for confirmation. If the residue level continues to exceed 0.1 ppm, the Agency will take regulatory action to insure that TCDD is reduced to an acceptable level.[9]

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A second study of the TCDD residues in technical pesticides will begin in mid-1977. The limit of detection in this study will be 10ppb. Samples for this study will be taken by representatives from Pesticide Toxic Substances Enforcement Division, EPA. The data will provide EPA with a more comprehensive analysis of the intrinsic level of TCDD residues in the pesticides under consideration, prior to use.

C. Toxicological Effect Level

The TCDD toxicology data is well documented in the EPA conference report of January, 1976 and in the May, 1976 addendum and therefore does not need to be reviewed extensively herein. Additional data however have been generated which expand our knowledge of the risks associated with human and nontarget exposure to TCDD. Dow Chemical Company has recently completed a two-year feeding study with 2,3,7,8-TCDD in male and female rats. Preliminary data indicate that at a level of 0.001 ug/kg/day of TCDD (which approximates 20 ppt TCDD in the rat's daily diet) the effect was similar to controls in all parameters measured. At the dose of 0.01 ug/kg/day however increased urinary excretion of porphyrin and increased liver weights were observed (personal communication, Dr. Koriba, Dow Chemical Co.). Toxicologists from the Criteria and Evaluation Division (CED), OPP, EPA have reviewed this data and established a range of 80 to 200 ppt as the effect level (EL) for human exposure to beef fat containing TCDD. To determine the EL it was assumed that the amount of TCDD in the beef was constant and that the amount of beef fat ingested is from 1 to 2.5% of a humans total diet.

The data generated thus far for the 85 beef fat and 43 liver samples analyzed in phase I of the monitoring program do not indicate that the EL for TCDD exposure through beef fat ingestion has been exceeded or reached. It is emphasized however that exposure to TCDD through ingestion of beef fat is only one possible source of exposure. The environmental samples scheduled for analysis in phase II of the Dioxin Implementation Plan range from soil to human types. The diversity of these samples is intended to provide EPA with a better understanding of the potential for TCDD to bioaccumulate once it is released into the environment and thus present multiple sources of exposure to humans or other non-target organisms.

III. Future Analytical Studies

Phase II of the Dioxin Implementation Plan is designed to provide the Agency with precise analytical data on the residues of TCDD in environmental samples.

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The purpose of the design is to establish a practicable experimental procedure that (a) will permit development of a "best fit" recovery curve (or curves) for quantification of 35 CI-TCDD spiked in beef fat and liver at levels ranging from 0 to 100 ppt, and (b) will allow statistically reliable measurements of the following parameters:

1. The accuracy and precision with which ppt levels of 35 CI-TCDD added to beef fat and liver can be extracted at OPP's Pesticide Monitoring Laboratory and quantified at the collaborative analytical laboratories;

2. The accuracy and precision with which these analytical laboratories can quantify ppt levels of 35 CI-TCDD provided as standards;

3. The relationships between measurements of TCDD in standards and measurements of TCDD extracted from beef fat and liver spiked at the same levels as the standards;

4. The consistency of laboratory performance throughout the experiments, as measured by the relative magnitude of statistical interactions;

5. The precision of PML's extraction procedure relative to the precision of the GC-MS quantitation.

Based on the ability of the collaborator to detect TCDD in spiked samples, an evaluation can be made of the validity of the TCDD levels reported in blind environmental samples. It is anticipated that the above procedure can be applied to all environmental samples scheduled for analysis on phase II. Highest priority however will be given to the analysis of phase II beef (fat and liver) and human (fat, liver, and milk) samples.

The Agency presently has a total of 167 human samples (milk, liver, adipose) in storage at our Pesticide Monitoring Facility, Bay St. Louis, Miss. These samples were collected in Mississippi and Arkansas from persons who might have been exposed to TCDD through the use of 2,4,5-T on rice.

Additionally, EPA is establishing a voluntary biopsy and mother's milk monitoring program in Oregon, to further investigate the significance of direct and indirect human exposure to TCDD through the use of 2,4,5-T. This program is intended to provide EPA with information on the significance of indirect and direct human exposure to TCDD through the comparison of samples taken from persons living in urban versus forested sites, respectively.

For specific details on the phase II analytical procedures refer to Section V, Appendix, part B.

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IV. Summary

EPA is investigating the frequency and level of TCDD residues in the environment as basis for determining the toxicological risk associated with human and other non-target exposure to TCDD.

A. Phase I of the Dioxin Implementation Plan was primarily designed to identify acceptable research approaches for extraction and analysis of TCDD residues in environmental samples. Existing data indicate that the methods are satisfactory for analysis of beef samples (fat and liver) and that TCDD is present in a small percentage (3.5%) of the beef fat samples taken from cattle with a known exposure to 2,4,5-T. All of the beef liver samples analyzed were negative. As a part of phase I, the Agency is conducting further research to determine the acceptability of these methods for analysis of other sample types (humans, small mammals, birds, soil, etc.) and the optimal combination of extraction and analytical methods. The latter study will be short term (90 days) in order that the Agency might rapidly proceed with phase II analysis.

B. The Agency has analyzed 75 samples of pesticides which, due to their manufacturing process, could contain TCDD. Seventy three of the 75 samples analyzed, did not contain TCDD at or above the 0.1 ppm tolerance level set by the Science Advisory Committee in 1970. The 2 remaining samples ronnel, and Na-2,4,5-T phenate are believed to contain .107 ppm and .312 ppm of TCDD respectively. These samples will be reanalyzed for confirmation. If confirmed EPA will take regulatory action to insure that the level of TCDD in the affected pesticides is reduced to the 0.1 ppm level.

An additional analytical study for TCDD residues in technical grade pesticides will be conducted in 1977. This study will analyze a greater number of samples at a lower limit of detection (10 ppb) than the preceeding analyses. EPA is presently selecting an analytical laboratory for this research.

C. Phase II of the Dioxin Implementation Plan is intended to provide the Agency with increased information on the range and possible tendency of TCDD to bioaccumulate in the environment.

All analyses in phase II will be based on a statistical approach designed to improve the precision of the quantification of TCDD residues reported.

Analyses of the human (fat, liver and milk) and beef (fat and liver) samples now in storage will receive the highest priority when the Agency proceeds with phase II of the plan.

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D. Existing beef fat and liver analytical data from phase I of the Dioxin Implementation Plan do not indicate that the toxicological effect level for exposure to TCDD through ingestion of contaminated beef, has been exceeded. This is only one source of exposure however. Additional analytical data are necessary to assess the overall toxicological risk associated with accumulative exposure from different sources of TCDD.

In addition to the human samples now in storage, EPA is establishing an elective biopsy and mothers milk program in Oregon to further assess the potential for human exposure to TCDD through the use of 2,4,5-T.

V. Appendix

A. Interpretation of Phase I Data by Analytical Collaborators

A meeting of the analytical collaborators (Dow Chemical, Harvard University, and Wright State University) was held on June 15, 1976, to discuss the results obtained to date. As a result of this meeting the following statement was issued by the analytical collaborators.

1. Of the beef fat famples (85) analyzed, one shows a positive TCDD level at 60 ppt; two samples appear to have TCDD levels at 20 ppt; five may have TCDD levels which range from 5-10 ppt. While several laboratories detected levels (5-10 ppt) in this range, the values reported were very near the sample limits of detection. There exist a great deal of uncertainty of the procedure below 10 ppt.

2. The analytical method is not valid below 10 ppt

3. An introduction to a neutral extraction technique shows promise of the capability of detecting levels below 10 ppt. This was demonstrated by comparative data at the lower parts per trillion range (5-10 ppt). However, this method has been demonstrated by only one laboratory at this time and has not been validated below 10 ppt by another competent analytical facility.

4. The samples analyzed were peritoneal fat and kidney fat taken from cattle which had grazed on rangelands of known treatment with 2,4,5,-T. Controls were the same sample type taken from cattle from non-treated areas within the same state.

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5. Of the liver samples (43) analyzed, only one sample suggest any TCDD residue, but the residue observed was to close to the sensitivity of the sample detection limits for quantitation. The fat sample analyzed from the same animal showed no TCDD residue. Three liver samples (for which fat samples were analyzed and showed positive data) showed no TCDD residues.

6. None of the collaborators reported TCDD in samples of beef fat taken from cattle in non-treated areas (at the sensitivity of the analytical method). Three of the laboratories receiving liver samples from cattle in non-treated areas observed no TCDD in the samples.

Due to the improvement and agreement among the analytical collaborators with the analytical data, the above data supercedes the EPA beef fat monitoring data released in memoranda dated August 5, 1975 and December 19, 1975.

B. Phase II Experimental Design

The design phase II calls for preparation of two "pools" of control beef fat (say, Pool F and Pool G) and two pools of control beef liver (Pool L and Pool M) from which all spiked samples are to be constructed. The fat pools are constructed from equal amounts of fat from each control animal selected, using a separate set of animals for each pool. Liver pools are constructed in a similar manner. (Necessary pool sizes are to be determined by Dr. Aubry Dupuy after study of the design).

Eleven samples each are prepared from fat pool F and liver pool L. The samples from each pool are spiked individually at levels between 0 and 100 ppt of 35 Cl-TCDD. Samples are then extracted, and the extract is divided into three equal aliquots for shipment to the analytical labs, (the spiking levels are systematically spaced). The spiking system allows close spacing at lower levls and moderate increases in spacing at higher levels).

Next, five samples each are prepared from fat pool G and liver pool M. The samples from each of these pools are spiked individually at levels between 0 and 100 ppt of TCDD. These samples are extracted and divided into three equal aliquots for shipment as above.

It is necessary that each laboratory receive enough extract from sets G and M and from the comparably-spiked samples of sets F and L to allow duplicate measurements of each sample. For other samples, labs need receive only enough extract for a single measurement.

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A single series of standards, prepared as set S and set T, will serve for comparison both with fat and liver samples. Set S will comprise eleven aliquots spiked at levels, comparable to fat set F and liver set L.

Standard set T will contain 5 aliquots spiked at levels comparable to fat set G and liver set M. Again labs must receive enough standard from set T and corresponding levels of set S to permit duplicate measurement of each standard.

Thus, a total of 48 samples -- 16 standards, 16 fat and 16 liver -- are needed; these will require a total of 78 measurements by each laboratory, counting duplicate measurements of specified samples. A diagram of the design is attached.

All samples -- fat, liver and standards -- are to be prepared and shipped in random order, except that aliquots from a given sample wil be shipped to the three labs simultaneously. Laboratories are to analyze the samples in the order in which they are received. Labs are to perform blind analyses, i.e., they are not to know either the origin of the material or the level of TCDD in any sample. A sample numbering system should be used that provides no clue to sample identity.

All data will be used to develop recovery curves. Data from duplicate analyses of replicated samples will be used to measure extraction and GC-MS precision. Data evaluation will be by analysis of variance and regression methods.

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26 APR 15..

TCDD (ppt)	Standard Measurements				Beef Fat Measurements				Beef Liver Measurements			
	Pool Code	Lab. A.	Lab. B	Lab. C	Pool Code	Lab. A	Lab. B	Lab. C	Pool Code	Lab. A	Lab. B	Lab. C
A	S	2	2	2	F	2	2	2	L	2	2	2
A	T	2	2	2	G	2	2	2	M	2	2	2
B	S	1	1	1	F	1	1	1	L	1	1	1
C	S	1	1	1	F	1	1	1	L	1	1	1
D	S	1	1	1	F	1	1	1	L	1	1	1
E	S	2	2	2	F	2	2	2	L	2	2	2
E	T	2	2	2	G	2	2	2	M	2	2	2
F	S	1	1	1	F	1	1	1	L	1	1	1
G	S	2	2	2	F	2	2	2	L	2	2	2
G	T	2	2	2	G	2	2	2	M	2	2	2
H	S	1	1	1	F	1	1	1	L	1	1	1
I	S	2	2	2	F	2	2	2	L	2	2	2
I	T	2	2	2	G	2	2	2	M	2	2	2
J	S	1	1	1	F	1	1	1	L	1	1	1
K	S	2	2	2	F	2	2	2	L	2	2	2
K	T	2	2	2	G	2	2	2	M	2	2	2
ot. Pools	16				16				16			
ot.		26	26	26		26	26	26		26	26	26

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